JANUARY 1971

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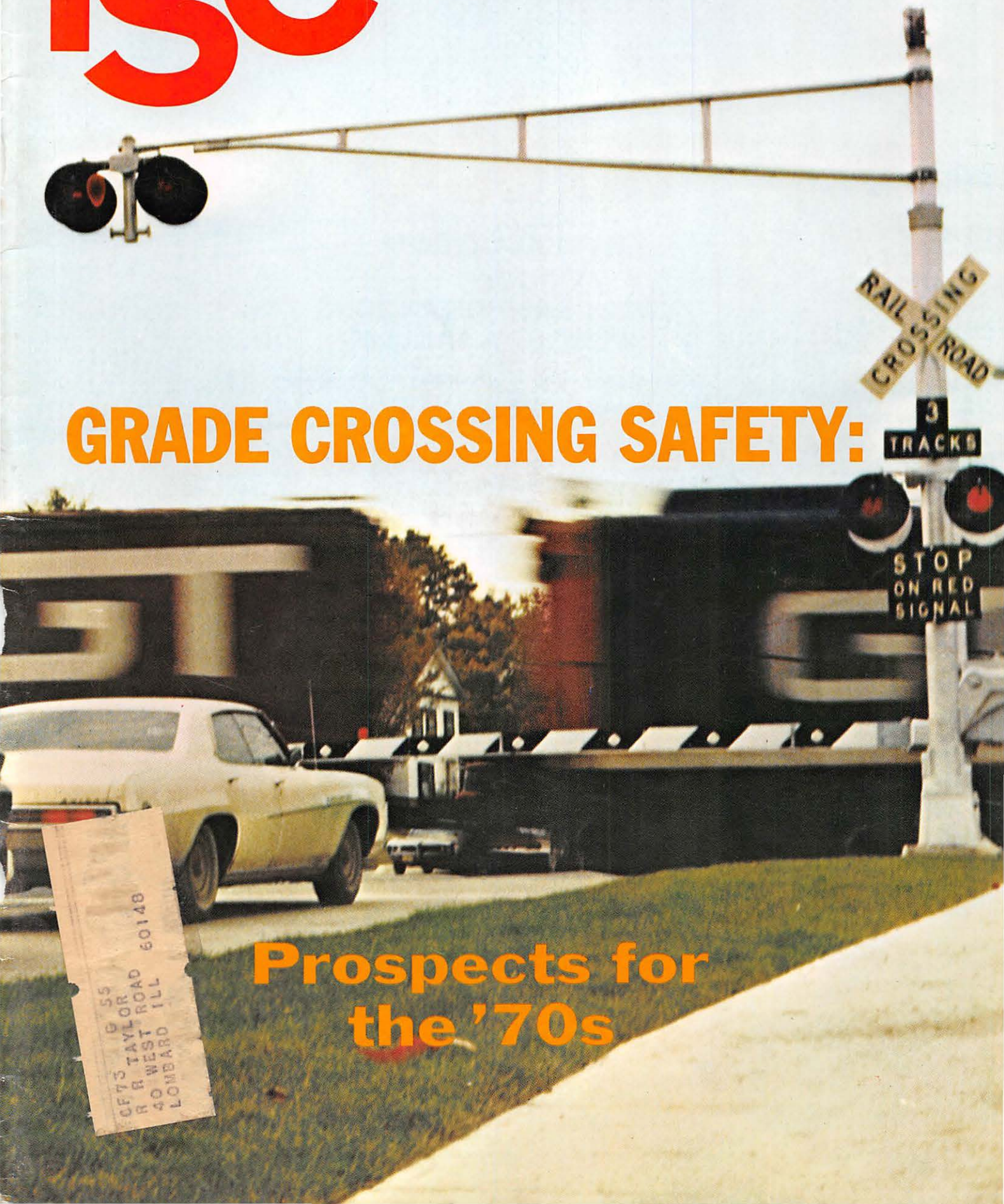
RAILWAY SYSTEM CONTROLS



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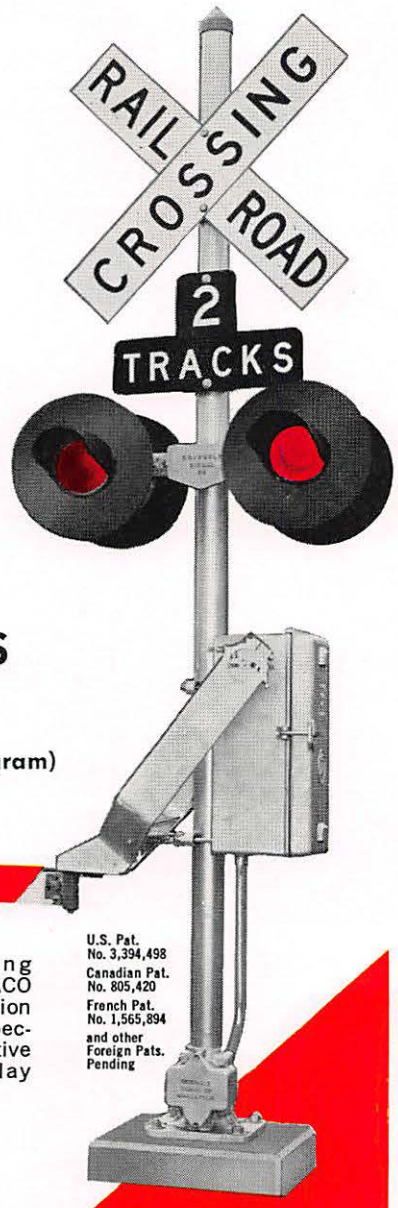

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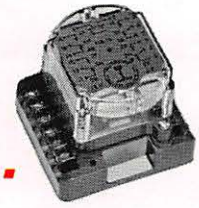

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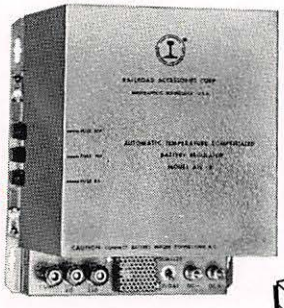

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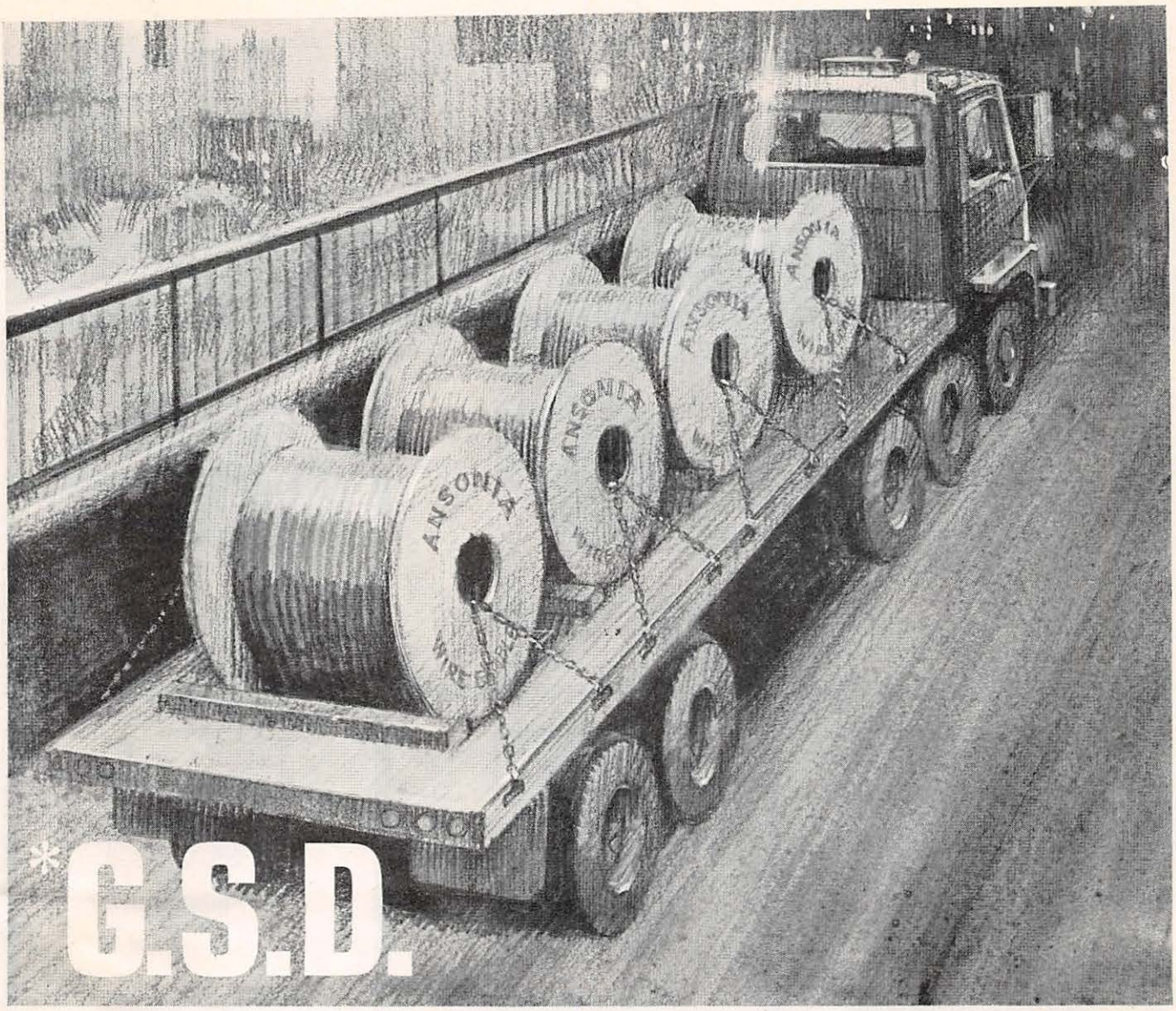

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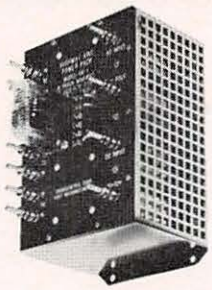

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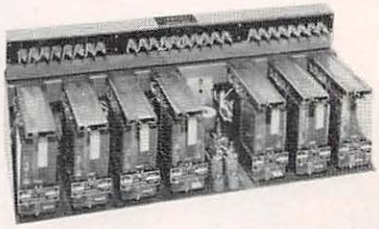
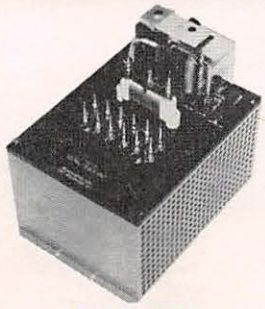
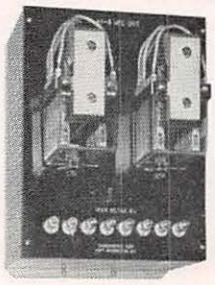
H X 2 UNIT
PROVIDES CONTINUOUS SIGNAL LIGHTING POWER OF MAX. 20 AMPS. AND BATTERY CHARGING CURRENT OF MAX. 10 AMPS



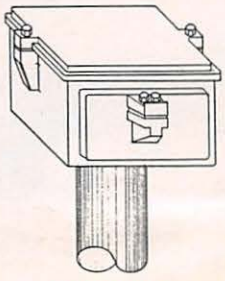
H X 3 UNIT
RELAY LOGIC UNIT FOR CONTROL OF SINGLE TRACK HWY. XING. RELAYS ARE PD 1 PLUG IN TYPE



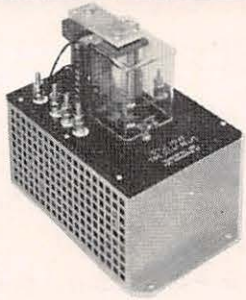
H X 5 UNIT
PROVIDES ISLAND TRACK CIRCUIT WITHOUT INSULATED JOINTS



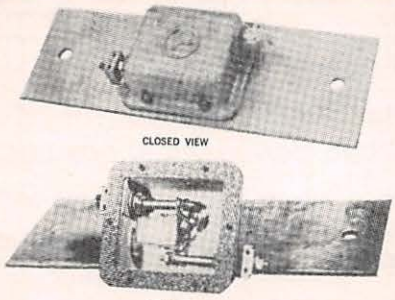
H X 6 UNIT
TRANSCEIVER UNIT FOR "UFO" JOINTLESS HWY. XING TRACK CIRCUIT



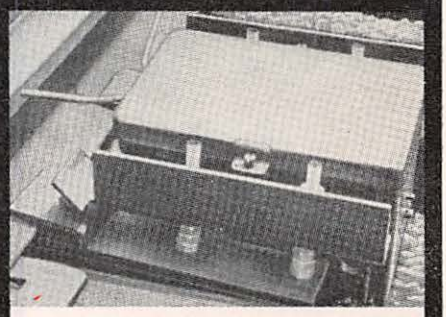
H X 7 UNIT
COUPLING UNIT FOR "UFO" JOINTLESS HWY. XING TRACK CIRCUIT



PD 1 XT TIME DELAY RELAY
PROVIDES FAIL SAFE CIRCUIT FOR PREVENTING LOCKOUT OF DIRECTIONAL STICK RELAYS



S T 3 RECTIFIER
TRACK UNIT FOR AC, DC TRACK CIRCUIT



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JANUARY 1971 VOL. 2 NO. 1

RSC RAILWAY SYSTEM CONTROLS

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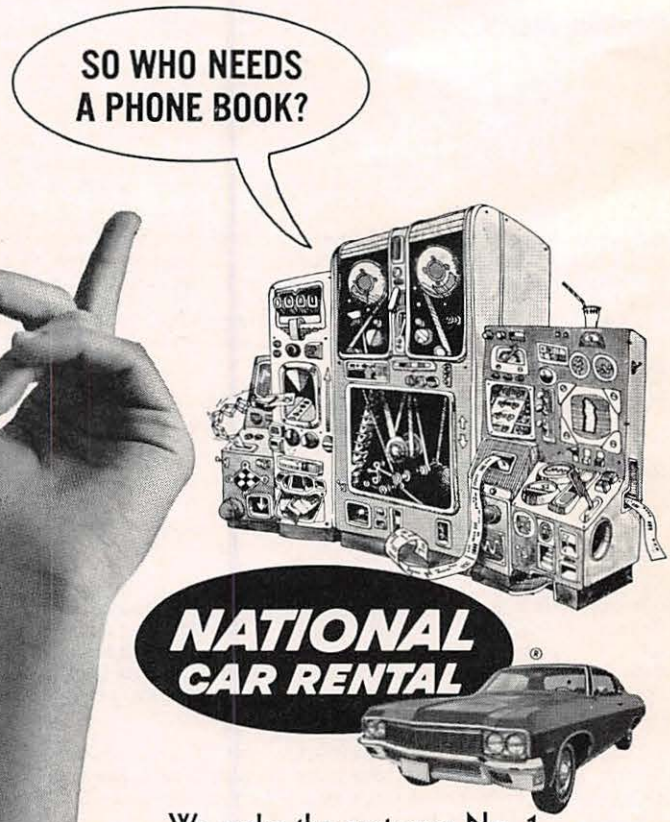

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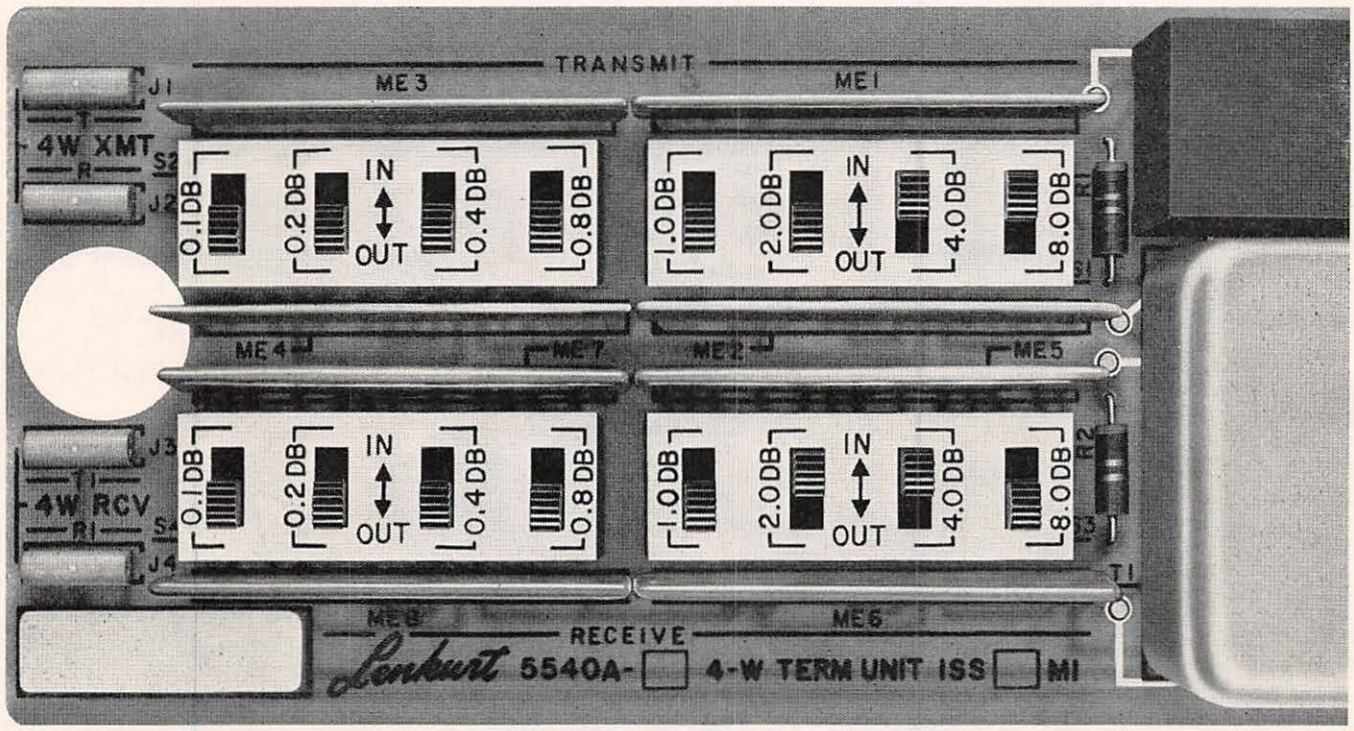
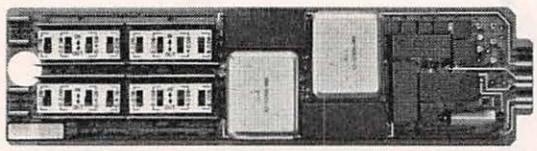


Now you don't need to fight a huge inventory of extra pads when you want to make adjustments. Flick a few switches, and it's done.



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Grade crossing safety gains

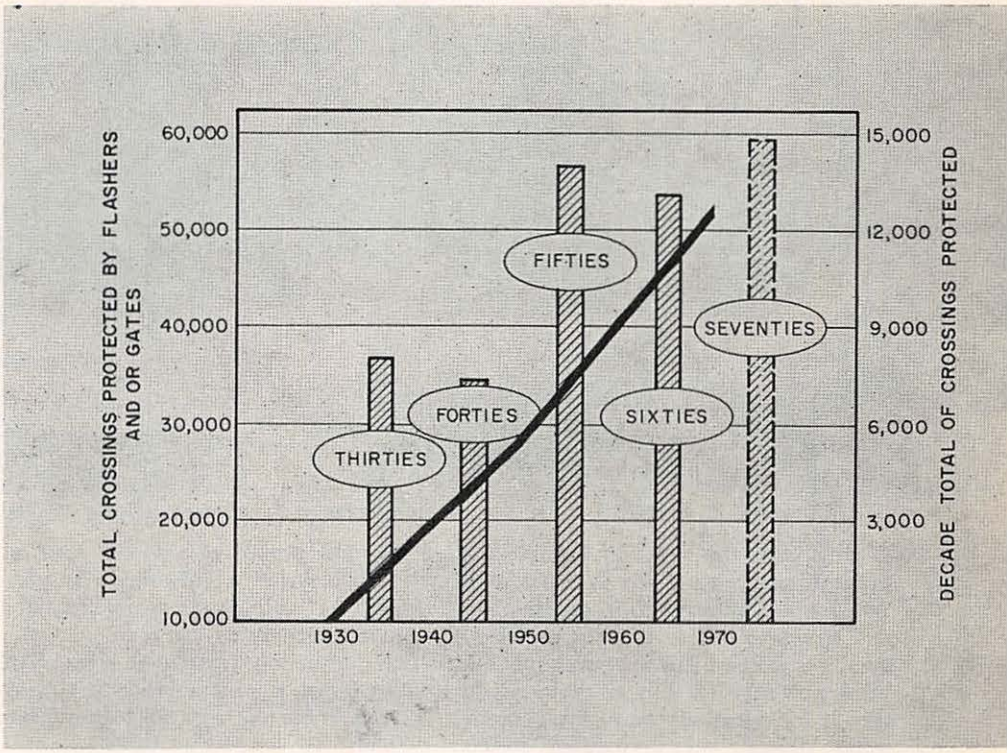
Current estimates are that considerable effort will be made during the Seventies to improve safety at railroad-highway grade crossings. As the chart indicates, installations of automatic protective devices should hit the 15,000 mark during this decade. The chart gives figures for the U.S. and Canada. Through 1970, data provided to *Railway System Controls* indicates approximately 56,000 crossings are now equipped with flashing-light signals with or without automatic gates. Of these, some 45,000 grade crossings are in the U.S.

Although fatalities from rail-highway grade crossing accidents represent only 2-3% of the total killed on U.S. highways each year, there is evidence that the public through Congress wants this figure reduced even more. Under the Federal Railroad Safety Act of 1970, the Secretary of Transportation is directed to submit to the President and the Congress within one year of enactment a comprehensive study of the problem of eliminating and protecting railroad grade crossings, including a study of measures to protect pedestrians in densely populated areas along railroad rights-of-way. Also, he must undertake a coordinated effort toward solving the grade crossing problem.

In 1969, there were 3,774 crossing accidents involving pedestrians and vehicles with trains which resulted in 1,490 deaths and 3,669 injuries. These figures are the lowest since 1966, and some observers hope it's a forecast of improvement in crossing safety.

Greater safety is traced by experts to continuing emphasis in driver training courses, especially in the high schools on the dangers of grade crossings, and to the continued programs by railroads and local and federal governments in upgrading protection equipment at crossings.

For railroads, a good sign is that of public awareness of its responsibility for improving safety at rail-highway grade crossings. It is generally accepted now that the motoring public should pay a large portion—in some cases 90%—of the cost of equipping crossings with automatic protection equipment.



MANAGEMENT INFORMATION

Rail-highway grade crossing safety is now receiving attention from all levels of government—federal, state and local—the railroads and manufacturers of crossing protection equipment. What is relatively new is increased interest by the federal government. For example, the 1970 Safety Act directs the Secretary of Transportation to develop a comprehensive program for improving safety at crossings. AAR's ASTRO report recommends using 10% of the federal highway trust fund for grade crossing projects.

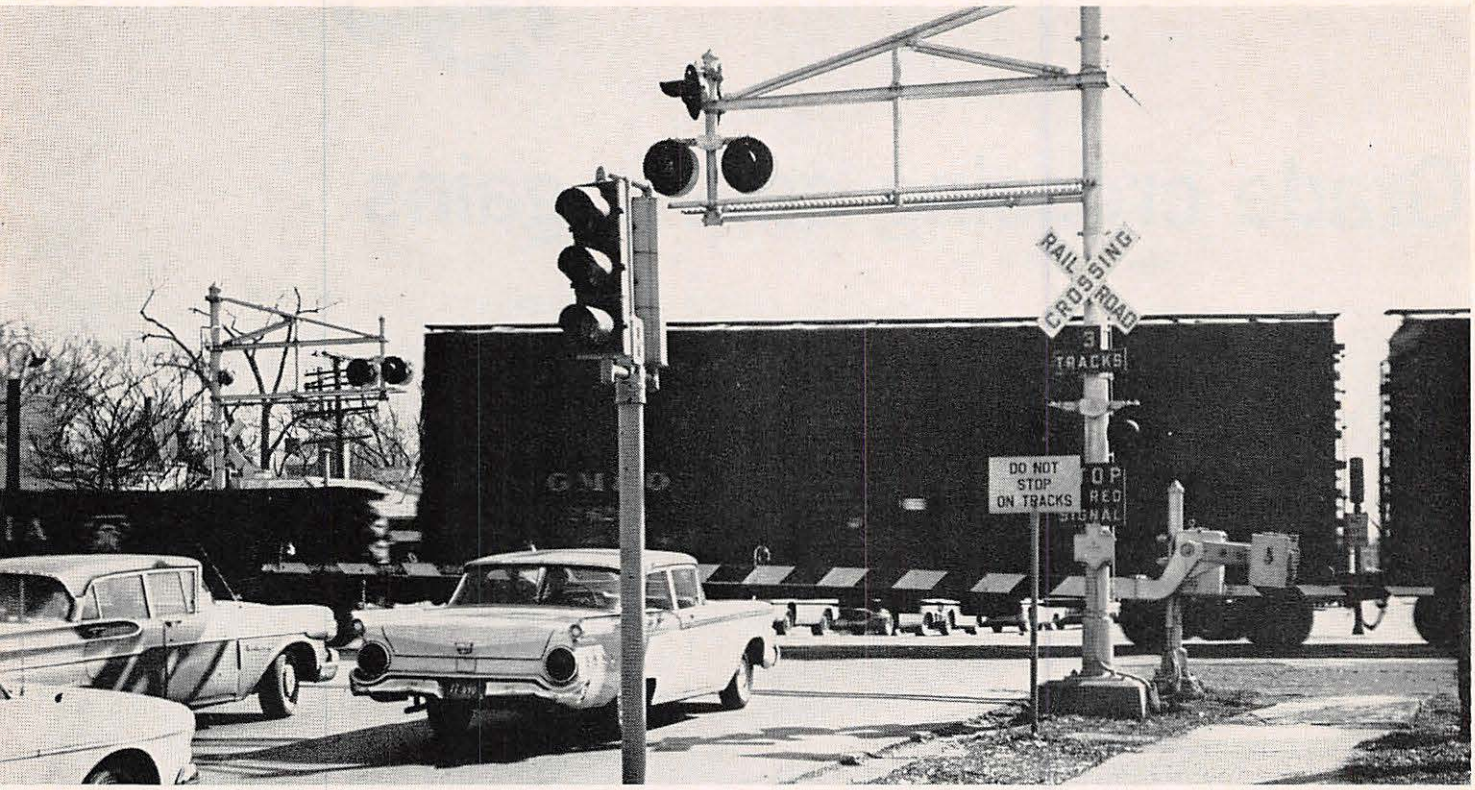
Factors important to grade crossing safety include the following:

—3,774 crossing accidents resulting in 1,490 deaths and 3,669 injuries in 1969, the lowest since 1966. The deaths represent only 2-3% of the total killed on U.S. highways each year.

—Federal, state, county and city aid is available for installation of automatic protective devices. Not all such governmental agencies participate, but over 90% of the states provide some matching funds. A few states, notably California, provide maintenance funds for crossing protection equipment.

—Nine manufacturers provide automatic protection devices and/or controls in an annual market of approximately $12 million.

—Automatic flashing-light signals with or without gates are being installed at 1300-1500 rail-highway grade crossings each year.



STREET TRAFFIC SIGNALS are often interconnected with crossing signals to improve safety at grade crossings.

Obviously, the best way to eliminate grade crossing accidents is to make it physically impossible for automobiles and trucks to collide with trains. However, the cost of grade separations has been put at $100 billion or more for the 225,000 rail-highway grade crossings. Where several parallel streets cross a railroad, a solution found to be reasonable in cost and in safety by many communities is to construct one or two grade separations—overpasses or underpasses—and close the remaining crossings. In the high density traffic area of Long Island, that railroad at state expense has elevated its commuter lines through several communities.

A less costly approach has been suggested by Alan M. Voorhees Associates in a study for the Federal Railroad Administration. Improvements costing $580 million to 30,000 rail-highway grade crossings could reduce accidents by 25%, the study reported. Other recommendations in the study were: to develop special devices which will help reduce accidents at grade crossings with low vehicle and train volumes; improve cost/benefit information as a basis for selecting improvement projects of merit; and eliminate all unnecessary crossings and provide protection for the crossings allowed to remain.

The Federal Railroad Safety Act of 1970 instructs the Secretary of Transportation to undertake a comprehensive study and report within one year on the problem of eliminating and protecting railroad crossings, including a study of measures to protect pedestrians in densely populated areas along railroad rights-of-way, together with his recommendations for appropriate action.

One of the key elements in any grade crossing protection program is money. Who's got the money? Local, state and federal governments, that's who! Fortunately, some states back in the 30's—Illinois being one of the pioneers—recognized that the motoring public should help pay for crossing protection equipment. Ratios used by many local and state governments are 5% city, 5% county, 10% railroad and 80% state funds for installation of crossing protection devices. In many cases, where the crossing is of a state highway only, the state will pay 90% of the installation costs. California will now pay a portion of the cost of maintaining crossing protection equipment on state highways.

At present, states may use 10% of the Federal highway trust fund for grade crossing projects, but it is not mandatory. America's Sound Transportation Review Organization report recommends that states be required "to devote 10% of the Federal highway trust fund to grade crossing projects; remove restrictions that limit such funds to Federal aid highways. Establish uniform Federal Safety Standards for all grade crossings."

Additionally, the ASTRO report recommends creation of "a Federal Transportation Fund from which railroads may obtain money for . . . maintenance of grade crossings. Establish a loan-guarantee program of up to $400 million annually to further assist right-of-way improvements." Such improvements, say some, would include automatic protection devices at grade crossings. Also, maintenance of grade crossings should include the protection equipment.

Railway System Controls surveyed nine manufacturers of automatic protection equipment used at rail-highway grade crossings and asked: What can be done to improve safety at highway-railroad grade crossings? As might be expected answers covered three major areas: money for improvements, better driver education, and use of reliable and proven control devices and equipment.

"Fundamentally, the question is one of economics. Given a finite number of dollars to apply to this specific area, and given the objective of improving safety, what way of investing the dollars gives the largest reduction in accidents? We're really looking for the largest return on investment," states Hall E. Downey, manager advertising and sales promotion, General Railway Signal Co.

"Grade separation, of course, achieves 100% accident reduction, but the reduction is very costly in terms of dollars per accident prevented. If we're looking to achieve the best return on investment on our accident prevention funds, we can best achieve it by simply applying the known, tested, practical solutions—gates or flashing-light signals—to more crossings. We should use protective arrays that are economical and simple to install and maintain—a pair of maintenance-free aluminum signals or gates, for example, and a control circuit based on frequency shift overlay track circuits. With FSO, you not only get full, failsafe, closed circuit track circuit protection, but you also concentrate all the 'maintainables' and the power line drop at the highway crossing," Downey says.

Although grade separation achieves 100% accident reduction, the cost can be quite high. For example, the Long Island is embarking on two projects at the present time covering elimination of 24 grade crossings by construction of underpasses or elevating the rail lines. At Massapequa Park, three grade crossings will be eliminated at a cost of $7 million, the funds being supplied by New York's Department of Transportation. In another project started last year, $58.3 million will be spent to eliminate 21 rail-highway grade crossings on the Long Island. To provide automatic gates and flashing-light signals at 52 crossings, LI has completed about 40% of this $1.1 million project.

"A concentrated effort to improve the safety of rail-highway grade crossings should consist of three areas of activity," says Robert E. Harmon, president, Harmon Electronics, Inc. "The first is improved public education. Much can be done to make the driving public more aware of the hazards of rail crossings and the meaning of the protection equipment in use.

"The second is increased public investment to provide and improve automatic protection at an increased rate.

"The third area, and the one most subject to efforts by the railroads and supply industry, is technological improvements in the actual crossing warning systems themselves. These improvements should include development of the following: (1) Better, more visible warning devices. (2) Better control systems to reduce unnecessary operation of the protective devices, particularly at very busy crossings. (3) Total protective systems that are lower in cost with easier and faster installation to

Grade separation achieves 100% accident reduction.

allow adding protection to larger numbers of presently unprotected crossings," Harmon says.

"Factors involved in the improvement of safety at crossings include improved vision for the highway driver, better protection in the line of flashers, gates, cantilever-mounted signals, etc., as well as adding good advanced warning signs including operational signs and most of all, of course, a grade elimination," says Howard C. Palmer, vice-president marketing, Signals and Controls division, Marquardt Industrial Products Co.

"The following are of major importance to improving any crossing: (1) Provide gates and/or flashers with good visibility for highway traffic. (2) Install good advance warning signs using the operational type where possible. (3) Improve vision of highway traffic at the crossing as geographic conditions permit. (4) Increase education of drivers on observation of crossing protection.

"(5) Install whenever desirable control equipment which will provide the least possible delay to the traveling public. This would include uniform warning time control equipment for the crossing which would provide minimum safe warning time with trains of various speeds as well as operation of the protective devices only when necessary. That is to say, that when switching operations or train moves occur in the approaches, but do not cross the street or highway that the protection equipment is not activated. Our Grade Crossing Predictor provides this type of control," Palmer said.

"To improve safety at rail-highway grade crossings first requires that more money be made available so that more of the 'dark' crossings can be equipped with train-actuated protective equipment at a faster rate than has historically prevailed," says Harrison A. Scott, president, Railroad Accessories Corp.

Crossing safety needs money and driver education.

"Secondly, more attention must be given to the education of highway vehicle operators in the meaning and observance of rail-highway crossing signs and signals. There should be as great a penalty applied to failure to observe rail-highway crossing signs and signals as is applied to failure to observe a highway sign or signal," Scott says.

Four ways to improve safety at grade crossings are mentioned by Robert A. Lockwood, vice-president for national marketing, Servo Corp. of America. "(1) Speed selection circuits will make the operating time more uniform for trains of varying speeds thereby increasing the public's confidence in highway crossing protection. (2) Advance warning signs along the highway approaches will give the driver more warning time. (3) Improved optics in the highway crossing signals will provide a brighter indication to drivers. (4) Reduction of unnecessary operation of crossing signals at switching yards will improve safety."

"One of the biggest improvements to highway-railroad grade crossing protection would be a better educational program for drivers," says Carl L. Henricks, general sales manager, communications and signals, Western-Cullen division, Federal Sign & Signal Corp. "As long as you have a driver behind the wheel of any vehicle, there is no such thing as adequate grade crossing protection.

"Involved public and state agencies must educate people. Drivers' tests should include recognition of signal systems of all types—flashing signals, gate mechanisms, advance warning signs, etc.

"Actual figures depicting the high rate of accidents involving railroad grade crossings should be published, so that the public becomes more aware of these accidents. Maximum enforcement on obeyance of signals at railroad grade crossings should be a continuing objective.

"It should be the responsibility of both the states and the railroads that every crossing should be protected with at least flashing-red signals because many accidents occur at railroad crossings that just have, at the present time, the barest minimum crossbuck sign," Henricks says,

In accidents in 1969 involving motor vehicles, 537 persons were killed at crossings having automatic protection devices or a watchman or trainman was flagging the crossing. At crossings protected only by signs not of a type indicating the approach of a train, 844

persons were killed in grade crossing accidents.

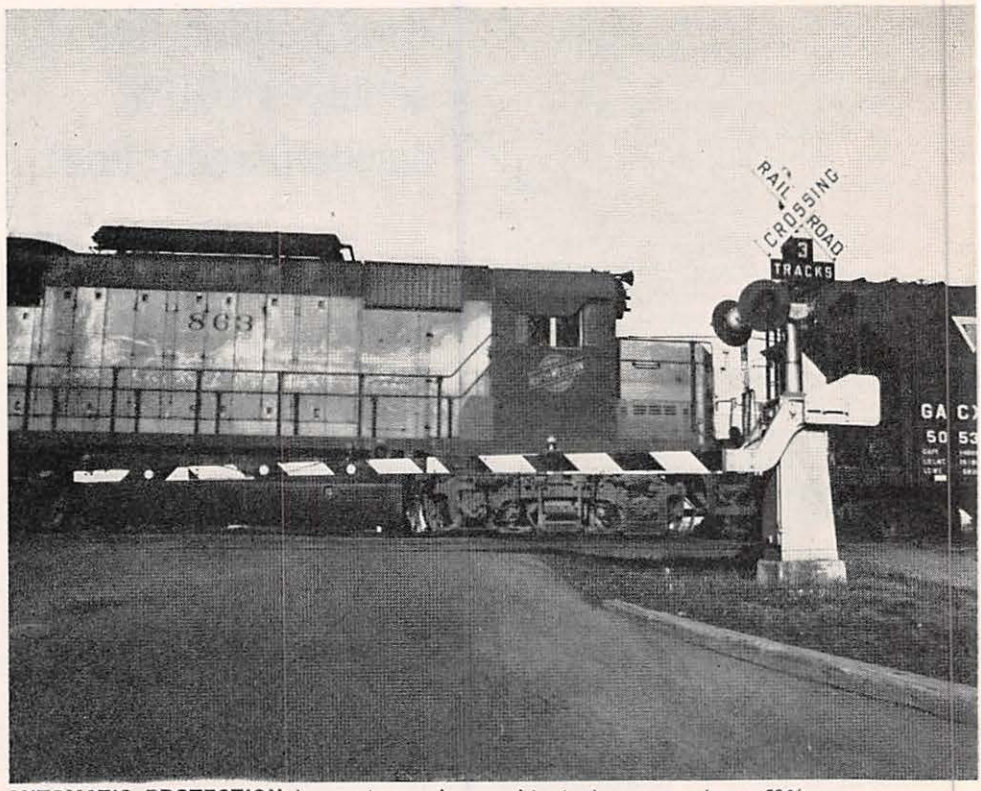
"The following things could be done to improve safety at grade crossings" says John W. Hansen, manager marketing communications, Signal & Communications division, Westinghouse Air Brake Co.

"(1) Require gates at all grade crossings. (2) Increase psychological impact of warning signals—the use of flashing red is inconsistent with common use of flashing red with traffic signals. In the case of highway crossings, flashing red was used originally to simulate wig-wags or improve the attention-getting power; however, flashing red with traffic signaling indicates permissiveness. (3) Change the message conveyed by a grade crossing signal from one of 'maybe there is a train coming' to 'if I don't stop I will be killed.' (4) Floodlight the crossing area. (5) Require more extensive use of retro-reflective striping on all rolling stock," says Hansen.

Are present methods of protecting rail-highway grade crossings effective? Yes, and indications are that the number of accidents with resulting deaths and injuries would be considerably higher if automatic protective devices were not installed at grade crossings. For example, a report by the California Public Utility Commission concerning financial assistance granted from the grade crossing protection fund on 367 crossings refers to statistics for accident experience for three years before and three years after the installation of automatic protection equipment. The total number of accidents had been reduced from 874 to 303, the number of deaths reduced from 124 to 25 and the number of persons injured reduced from 413 to 89.

"A safety study for 498 crossings protected by the Grade Protection Fund where the new signals had been in service 12 months or more, a total of 37,861 'crossing months' experience with the new protection and service indicated some significant results," reported James A. Parker, railroad engineer, Illinois Commerce Commission. "Accidents were reduced by 68%, fatalities by 78% , and injuries by 80%. This decrease appears even more favorable considering the increasing volume of highway traffic."

Another factor making the Illinois Commerce Commission grade crossing program effective is a law which gives the Commission the power to close and abolish crossings not required by public convenience and necessity. "At Lincoln, Ill., the Gulf, Mobile & Ohio runs directly through the middle of the town. Gates and signals were installed at seven crossings on Dec. 1, 1939. At the same time, the five remaining crossings were closed to vehicular traffic. In a 10-year period preceding that date, 50 persons had been injured, 26 fatally, at the 12 crossings. During the following 29 years, 2 accidents have been recorded, only one of which was fatal and that involved a pedestrian crossing on a sidewalk which had been left when the roadway was closed," Parker reported.



AUTOMATIC PROTECTION has cut crossing accidents by as much as 68%.

Public responsibility for grade crossing safety has been pinpointed by the Interstate Commerce Commission in report No. 33440, Jan. 1964 and sustained by the U.S. Supreme Court in 1966. Key findings in the report included: "That the principal cause of grade crossing accidents is failure of motor carrier operators to stop or exercise due care and caution or to observe and comply with existing safety laws and regulations.

"In the past it was the railroad's responsibility for protection of the public at grade crossings. This responsibility has now shifted. Now it is the highway, not the railroad, and the motor vehicle, not the train which creates the hazard and must be primarily responsible for its removal.

"Highway users are the principal recipients of the benefits flowing from rail-highway grade separations and from special protection at rail-highway grade crossings. For this reason the cost of installing and maintaining such separations and protective devices is a public responsibility and should be financed with public funds the same as highway traffic devices," ICC reported.

What the public wants and needs is a simple, very inexpensive, yet sophisticated grade crossing control system. Such a system will never fail, yet bar the motorist at the last possible second before a train would hit him if he proceeded over the crossing. There is some interest by the Office of High Speed Ground Transportation, Federal Railroad Administration. M. B. Mitchell, acting director, OHSGT, explains:

"We are actively seeking to develop low cost advance warning systems for protection at highway-railway grade crossings. There is a critical need for reducing the present cost of from $10,000 to $40,000 per crossing for this protection. We want to develop more sophisticated sensing systems, especially to control highway traffic flow based on train speeds. Several such systems are currently under review and we want to take the more promising into actual demonstrations."

As for costs of crossing protection equipment, WABCO's Hansen points out that the visible portion—flashers and gates—represents about 10% of the system. "The remaining 90% en-

compasses the control system that automatically detects an approaching train, determines its direction of travel, actuates the warning signal in sufficient time to permit the motorist to either clear the crossing or stop short, and finally turns off the warning signal when the train departs.

"That 10/90 ratio also applies to the relative cost of the protection system and results in the unseen portion being responsible for most of its cost. Another unseen portion of the cost is installation labor. Today installation labor costs almost as much as the equipment. A reduction of 50% in material cost will result in approximately a 25% reduction in total cost," Hansen said.

"To cope with rising costs and at the same time provide improved crossing protection requires a considerable amount of development and innovation. However, there is a limit to innovation, the primary one being public regulations imposed by many states that require a change in law to approve a simple change . . . Easily revised regulations, standard on a nationwide basis would be more effective.

"No railroad will attempt to utilize a new type of equipment if it is not in accordance with existing standards and regulations; the legal implications of non-conformance are obvious.

"We find that improved products tend to make older equipment still in service subject to legal claims that the protection was not as good as it might have been. Although this should not be allowed to affect product improvement, it is a problem today," Hansen said.

Another factor to be considered in the area of product improvement is that many companies are finding that it may take 3 to 4 years of sales of a new product or an improved one to pay for research and development costs with no profit being made during this period. This tends to inhibit innovation unless the potential market is considerable.

However, the annual market for crossing protection equipment is running at about $12 million, and with nine suppliers in the field, the individual company share can be considered relatively small. From the list of suppliers (shown on page 13), it can be seen that a firm's share depends upon its ability to supply total systems —flashing-light signals, gates and controls. Accordingly, all do not share equally. And compared to the funds spent on highway construction, the crossing protection market is really quite small.

One of the problems with the rather

GUIDE TO CROSSING PROTECTION EQUIPMENT

Erico Products, Inc., Electronics Division—Island overlay and pulse coded overlay track circuits.

General Railway Signal Co.—Flashing-light signal with accessories; highway crossing protection with wired case; aluminum flasher signal; type F aluminum gate; type D gate mechanism; and frequency shift overlay track circuits.

Harmon Electronics, Inc.—Model 1110B AFTAC non-modulated audio frequency track circuit system; 1111B AFTAC FM tone modulated track circuit system; 1110/1101BT/R island track circuit; 1140B motion detector; 1145B motion detector II; 1515A HFTAC high frequency short range track circuit; 1600A solid state grade crossing logic; 1700A solid state flasher; and complete highway crossing flasher unit.

Marquardt Industrial Products Co.—Grade Crossing Predictors, models 300 and 400; motion sensor; pulse modulated control overlay equipment; short range track circuit and electronic track circuit.

Railroad Accessories Corp.—DC track circuit components; AC-DC track circuit components; overlay circuit components; safety signs and signals including advance warning signs (operative and inoperative); flashing-light signals; signs with reflex reflective material; highway crossing gate mechanisms (standard mast mounted, pedestal mounted or lightweight mast mounted) with wood or fibreglass "breakaway" type arms; crossing bells. RACO-MIPCO can furnish components, provide package units for field installation or provide complete field installation on a "turn key" basis. Note: RACO now handles sales for Marquardt Industrial Products Co.'s line of crossing protection equipment as listed above under MIPCO.

Servo Corp. of America—Servomatic II switching area crossing control system which includes transducers, directional analyzers, directional sensing units and downtime monitors.

Transcontrol Corp.—PD1XT time delay relay; JA car counter; HX3 crossing control unit; HX3-GAL highway crossing code control unit; and UFO (unamplified frequency overlay) jointless track circuit for highway crossings.

Western-Cullen Division, Federal Sign & Signal Corp.—Flashing-light crossing signals; complete flashing-light cantilever crossing signals, model 10 automatic crossing gates; crossing bells and a complete line of test equipment.

Westinghouse Air Brake Co., Signal & Communications Division—Flashing-light signals; crossbuck signs; gate mechanisms and arms with striping in both standard black and white, and the new red and silver for increased visibility; constant time warning systems, train detection circuitry (audio frequency overlay, type C track circuits, etc.); motion detectors; improved HC-100 light units; gate arm adapters for aluminum gates; breakaway gate arms; and packaged crossing protection equipment with factory wiring to simplify installation in the field.

slow installation rate is that in many instances railroads cannot find economic justification for them to put the money into crossing protection equipment. even though the public may pay 90% of the installation costs, and in a few cases the maintenance costs. The primary reason crossing protection equipment is installed is by public demand through regulatory bodies.

Although more public funds will increase the installation rate, there are some limitations even today which can inhibit installation rates. They include shortage of system design engineers (very few crossings are alike) and shortage of installation labor. The labor and designer factors become especially critical when extremely short completion dates are ordered by public agencies.

A note on the legal aspects of grade crossing protection is mentioned by WABCO's Hansen: "Even though a grade crossing protection system meets all current regulations and specifications, today's courts invariably find the railroad at fault in an accident even when the motorist is obviously to blame. Unless the legal aspects of grade crossing accidents undergo a radical change to place the blame and resulting costs on the proper party, there will be a continued reluctance on the part of the railroads to voluntarily install automatic protection. After all, if the railroad is to bear the blame and costs for an accident, no matter what protection is installed, why should any be provided—especially with any of the costs being paid by the railroad."

Some state actions on the positive side not previously mentioned cover total funding in New York for the Long Island crossing projects, new types of advance warning signs in Missouri, Illinois formula for determining type of protection equipment and new type of sign at rural crossings in Indiana.

Long Island is now in the process of installing flashing-light signals and automatic half gates at 176 crossings. The $3.5 million project, estimated to take five years, is going at the rate of 36 installations during this current year, 17 during the second year and 41 each for the final three years. These are concurrent with New York State's fiscal years, as the funds are being supplied by the State Department of Transportation.

Louisville & Nashville, during 1970, installed 10 Missouri-type crossing signals. These signals consist of the standard crossbuck sign with a continuously flashing 12-inch diameter yellow light above and below each crossbuck. In a 1967 test in Missouri, the state highway commission paid a $250 share of the cost of a pair of the yellow flashing-lights installed at a crossbuck-protected crossing on each of four railroads. "The original 150-watt lights were reduced to 100 watts by order of the Public Service Commission late in 1967 as a result of complaints that the lights were too bright," states a report of Committee 9-Highways, American Railway Engineering Association, Nov. 1970.

Highway users are recipients of crossing safety.

The report continues: "The 20-year accident record at these four crossings prior to the installation of the 'blinking lights' reveals 8 separate accidents resulting in 8 fatalities and 12 persons injured. There have been no accidents since the installations were completed."

At some grade crossings in Indiana which include low-density vehicular traffic in rural areas, highway traffic STOP signs have been installed on each side of the crossings. Below the STOP sign is one reading "When Light is Out." Adjacent to the STOP sign is an 8-ft mast with back-to-back traffic light units with green lenses. The green light is tied in with the railroads' block signal circuits.

"The traffic light heads utilize 67-watt, 120-volt bulbs displaying a green light to motorists approaching the crossing, provided no train has pre-empted the XR relay. On approach of a train, the relay is de-energized and the green light is extinguished. The cost of the installation is less than $1,000. This installation is not considered 'fail-safe'," says AREA Committee 9 report in Nov. 1970.

Also being considered by some states is to provide a continuously operating signal at the crossing, such as a steady green when it is safe to cross, no train in the vicinity. This could change to yellow or flashing red on the approach of a train, and possibly use the conventional traffic signal steady red to indicate stop to the motorist. Traffic experts in many states and cities have pointed out that the grade crossing signal is unique and should be made to resemble standard traffic signaling.

One of the factors used by some states to determine whether a rail-highway crossing should be provided with automatic protection is known as exposure level. This is determined by multiplying the number of motor vehicles per day traveling over the crossing by the number of trains per day moving over the same crossing. A basic minimum for Illinois to upgrade protection from crossbuck to automatic signals is 3,000 vehicles per day and at least 2 trains per day over the same crossing. For single-track crossings in rural areas an exposure level of 25,000 is considered justifiable for automatic protection. For urban areas in single-track territory, the exposure level is 50,000. For multiple-track territories, rural exposure level is 15,000 and urban exposure level is 30,000.

Crossing signals should be paid for with public funds.

One question asked manufacturers of crossing protection equipment by *Railway System Controls* for this survey article was: What new crossing protection equipment have you developed within the last six months?

Erico Products, Inc., has developed island overlay and pulse-coded overlay track circuits. "Units have been out in the field under test for several months," reports Willard L. Gieger, general manager, electronics division.

General Railway Signal Co. has developed frequency shift overlay track circuits without requiring the use of insulated joints.

Harmon Electronics, Inc. developed an improved motion detector which provides restart and time-out and includes a self-check feature. A high frequency short range track circuit; solid state crossing logic eliminating the need for track, stick and XR relays; and a 40-amp solid state flasher are recent products. During the coming year, Harmon will have a complete highway crossing flasher unit.

Railroad Accessories Corp. recent developments include a new 12-inch diameter signal light and new approach warning signs and signals as developed by the Texas Highway Department. Current developments are in the nature of further improvement in signal lights and light sources: further development and improvement in control systems and packaging thereof for easier installations and maintenance and reductions in cost.

Servo Corp. of America is working on an audio frequency track circuit.

Transcontrol Corp. has developed the PD1XT time delay relay together with circuitry to prevent "lockout" of a directional stick relay due to track circuit failure.

Westinghouse Air Brake Co.'s Signal & Communications division has provided improved optics in the HC-100 light units; gate arm adapters to permit use of new aluminum arms on all manufacturers' gate mechanisms; breakaway gate arms with shear pins which can be easily replaced; and during 1971, the perfection of a constant warning time device.

Capital spending for system controls hits $105 million in '71

MANAGEMENT INFORMATION

Capital expenditures for communications, data processing and signaling equipment for 1971 may well reach $105 million. Railroads and transit authorities in the U.S. and Canada are planning to spend another $200 million plus for other than capital expenditures in the system controls area.

In other words, U.S. railroads plan for capital expenditures of $50 million in the system controls area, while Canadian railroads have capital equipment budgets in this area totaling $42 million for 1971. U.S. and Canadian transit authorities are planning capital expenditures totaling $13 million for communications, data processing and signaling during 1971.

CONTROLS BUYING COULD TOP $300 MILLION

	$ Millions		
	Communications	Data Processing	Signaling
Railroad			
United States			
Capital	20.0	5.0	25.0
Other than capital	30.0	75.0	37.5
Canada			
Capital	25.0*	2.0*	15.0
Other than capital	37.5*	10.0*	22.5
Subtotal railroad			
Capital	45.0	7.0	40.0
Other than capital	67.5	85.0	60.0
Transit			
Capital	5.0	0.2	7.8
Other than capital	7.5	3.0	7.5
Total Rail and Transit			
Capital	50.0	7.2	47.8
Other than capital	75.0	88.0	67.5
Total Equipment Expenditures	**125.0**	**95.2**	**115.3**

Note: "Other than capital" includes leased equipment costs.

* Canadian National Telecommunications and CP Telecommunications are communications common carriers in Canada.

For the communications 1971 capital budgets, a *Railway System Controls* survey of U.S. and Canadian railroads and transit authorities indicates the following: Class I railroads (U.S.)—$20 million: Canadian railroads—$25 million; and transit authorities in U.S. and Canada—$5 million. It should be noted that both transcontinental Canadian railroads (CN and CP Rail) are communications common carriers. In furnishing information for the survey they did not break out the railway portion of their communications spending plans.

In the data processing area, the $7.2 million capital equipment budgets break down this way: $5 million for U.S. Class I railroads, $2 million for Canadian railroads, and $200,000 for transit authorities.

The 1971 capital budgets for signal equipment are as follows: Class I railroads—$25 million; Canadian railroads—$15 million; and transit authorities—$7.8 million.

Total equipment spending by railroads and transit authorities comes to $335.5 million for 1971. Costs other than capital include leased equipment costs as well as replacement of equipment that is charged to operating or maintenance accounts. As the chart indicates, the costs under data processing are considerably higher ($88 million vs $7.2 million) for other than capital because most firms lease computers and their peripheral equipment.

On Feb. 15, revised (and generally higher) tariffs will go into effect for the Telpak bulk communications services. FCC ordered telephone and telegraph companies to "file revised tariffs that will extend the benefits of the Telpak shared rates to all private line customers without regard to their lines of business."

For railroads, as well as others, the relaxed interconnection regulations mean that they would not be required to lease the connecting or interface equipment from the telephone or telegraph companies. Some experts forecast that this will be an increased incentive for many railroads to purchase their own dial telephone exchange equipment, data sets and computer input/output units such as teletypewriters, all of which can be interconnected to the public telephone system. Many railroads will find it advantageous to purchase such units for their off-line traffic offices, which heretofore had to be equipped with telephone or telegraph company equipment.

Major trends in data processing and management information service activities that will be prominent in the years ahead include refining of computer programs to make them more efficient, ex-

COMMUNICATIONS EQUIPMENT INSTALLED 1966-1970

	1966	1967	1968	1969	1970
Miles of new or rebuilt pole line*	2,385	2,152	2,521	3,051	3,633
Miles of aluminum wire or cable installed*	2,833	2,606	1,509	1,252	3,077
Miles of copper wire or cable installed*	1,545	1,653	1,313	1,755	2,345
Carrier equipment installed					
Terminals and repeaters					
Voice only	1,822	2,536	2,771	1,884	2,264
Speech plus data	106	142	2,402	632	308
Data only	2,750	2,727	2,097	2,274	424
Microwave stations	85	79	102	186	335
Printing Telegraph Machines	4,472	2,770	2,542	5,176	2,688
Computer Input/Output Devices	—	—	—	558	872
Data Modems	—	—	—	1,059	934
Automatic Telephone Exchanges	102	61	63	54	31
Stations available	5,718	5,841	7,032	3,962	2,280
Radio					
Mobile units	6,655	3,831	3,854	3,448	4,032
Fixed stations	813	424	427	513	667
Portable units	4,237	1,894	2,776	2,342	2,944
Intercom or Loudspeaker Systems	76	119	68	75	113
Loudspeakers	757	2,424	905	1,010	3,854
Telephones	96	538	132	848	694
Automatic Car Identification Scanners	2	4	3	30	33
Other Communications Units	—	—	—	210	36
Totals	27,689	23,386	25,174	24,261	22,869

*Excluded from totals

SIGNAL EQUIPMENT INSTALLED 1966-1970

	1966	1967	1968	1969	1970
Traffic control and block signal systems					
Track Miles*	1,496	1,662	1,350	1,072	1,553
Signals	1,518	1,998	1,542	881	1,139
Power switches	297	473	301	160	274
Electric locks	400	277	237	189	285
Automatic train stops	143	743	120	90	27
Rolling stock with train stops or cab signals	68	214	162	101	723
Classification yards	5	2	4	5	7
Retarders	55	26	25	17	12
Power switches	220	115	257	168	115
Highway crossings protected					
With flashing lights only	761	1,079	986	913	1,010
With flashing lights and gates	459	638	625	504	572
Interlockings	60	84	65	45	57
Power switches	257	174	211	189	260
Signals	417	380	317	218	314
Safety detectors					
Dragging equipment	123	70	144	165	90
Clearance (high-wide load)	3	3	15	9	5
Hotbox	221	132	157	168	151
Presence	212	210	—	93	—
Loose or broken wheel	31	31	48	34	13
Slide fence feet*	10,424	116,700	18,351	7,212	21,084
Other signal devices	344	393	367	847	1,059
Totals	5,594	7,042	5,420	4,796	6,086

*Excluded from totals

panded interchange of data between railroads often on a direct computer-to-computer basis, greater use of simulation techniques for solving everyday problems, and exchange of programs among railroads.

"Exchange of waybill/car movement data offers our industry its greatest potential for cost reduction and service improvement," says R. O. Hughes, director management services, Detroit, Toledo & Ironton. At least 30 railroads are now exchanging data on per diem settlements via direct communications links or on magnetic tape. Shortly, AAR's TRAIN system and associated computer will operate on a test basis as a clearing house with five railroads in the area of car repair billing. The TRAIN computer will calculate each road's car repair charges including balances and forward complete information back to each road. Interline revenue settlements that average about 400,000 per month are also being considered for TRAIN computer processing.

At present, AAR's TRAIN system is handling about 4 million interchanges monthly, and producing 2 million junction slips monthly for the 66 participating railroads and some private car lines. Present efficiency is such that over 80% of the interchanges are reported by TRAIN's computer within 5 days of the actual interchange move. AAR has just received an IBM 360/50 computer which will replace the present 360/40 model.

Some railroads are handling interchange information to AAR's TRAIN via direct computer-to-computer operations. Others are using bisynchronous, high-speed transmission units such as the Mohawk 7201 or the IBM 2780.

Several railroads have exchanged computer programs—either free or for payment—and the practice will no doubt be widely expanded in the coming years. Burlington Northern, for example, purchased Candian National's network-analysis simulation program.

One of the complaints about data processing is that computers and their associated high-speed printers can inundate people with reports. Norfolk & Western recently held a 2-day "Operation Wastebasket" to determine what reports could be eliminated that are computer produced. Dr. Paul Zeis, director of research, reported that the N&W makes more than 5,000 different reports. About 4 million pieces of paper are printed monthly by the computers in Roanoke, operating 2,128 hours and printing about 100 million lines. In 1969, N&W spent approximately $2.5 million for forms and paper that weighed 1,820 tons.

Over 250 reports were eliminated from over 600 as a result of the two-day examination on the usefulness of reports on the N&W. In one instance, a daily form of 3,000 pages was eliminated. Many reports were consolidated with others and improved to provide more meaningful information.

With less than 10% of the interchange fleet unlabeled, the deadline for applying automatic car identification labels has been set back to May 1, 1971. AAR's Operating-Transportation Division General Committee made the move, according to one spokesman, to make the deadline more realistic, and one that can be met.

To speed up the labeling task, AAR's Mechanical Division has notified members and private car owners that "a Special Car Order will be issued effective Feb. 1, 1971 requiring that unlabeled empty cars be withdrawn from distribution and either properly labeled or sent home empty for application of ACI labels."

Additionally, the OT Division General Committee has recommended the following: "(1) That the effective date of refusing [unlabeled] railroad-owned or controlled trailers or containers be extended to Jan. 1, 1972. (2) That effective immediately foreign trailers or containers cannot be labeled without written consent of the owners. (3) That effective immediately all new trailers or containers must have ACI labels applied."

Signaling trends in the 70's

Main areas of interest during the coming years will include remote and centralized control of signal systems, means to reduce installation and maintenance costs, training of signal maintenance forces and removal of worn out or obsolete automatic train stop systems.

Increased use of welded rail—some 3,000 miles installed each year—has put pressure on signal engineers to provide longer track circuits thus reducing the number of insulated joints and the need for cutting welded rail. Conventional direct current track circuits for automatic block signals average 4,000 feet in length.

From the standpoint of installation and maintenance cost a longer circuit makes sense. If the signal block is 16,000 feet, four conventional direct current track circuits are required. Thus, there would be three pairs of insulated joints between signals. Insulated joint cost would be $300 plus annual maintenance of $600.

To provide just one track circuit for these long blocks, many signal engineers are using either center-fed DC or coded track circuits.

Using pulse modulated controls, a new type of electronic track circuit, Rock Island has eliminated 28 insulated joints and 60 miles of line wire used for control circuits in 20 miles of automatic block signal territory in northwestern Texas. RI is continuing this program of installing PMC controls and eliminating insulated joints and line wire controls, especially in territory where welded rail is to be installed.

Seaboard Coast Line, Southern and Penn Central have been given permission to remove intermittent inductive automatic train stop equipment from locomotives and wayside locations. Installed during the 1920's on order of the ICC, much of this equipment is now worn out or obsolete. An FRA ruling permitted Southern to remove ATS equipment operating over 2,765 miles of road, on the condition that the railroad spend the savings—from not having to modernize with new ATS units or maintain existing ATS—on upgrading and improving safety in the present signal system. The money Southern will spend on signal improvements—about $3.5 million for centralized traffic control—will be over and above improvements otherwise planned and budgeted.

SCL and RF&P will be able to remove ATS systems operating over 584 miles of road, while PC will remove ATS systems covering 1721 miles of road. In the SCL and PC cases, FRA has stipulated that the "proceeding remain open for further consideration of the issue regarding conditions such as were imposed in the Southern case." Southern volunteered to spend more than its savings from ATS removal on upgrading signal systems. Action by SCL and PC on this part of the matter has not been decided at this time. One conclusion seems clear, namely, that the many of the automatic train stop, train control and cab signal systems installed during the 20's will be removed during the 70's.

Trends in transit system controls show four major areas of intense development and installation: (1) centralized control centers for power, communications and signaling; (2) widespread use of two-way radio on all vehicles—rapid transit and motor vehicles as well as equipping supervisory and all police personnel; (3) System-wide station coverage with public address systems to inform the public of schedule changes and to improve operational control; and (4) application of automatic car identification to provide for automatic route control at junctions and to provide basic data for maintenance scheduling of cars.

OVER, 7,000 RADIOS WERE INSTALLED BY RAILROADS IN 1970

Railroad	Two-way Radio			Intercom Systems			No. of	Telephone	
	Mobile Units	Stations Fixed	Portable Units	No. of Systems	Loud-speakers	Tele-phones	Microwave Stations	Ex-changes	Stations Available
Alaska	—	—	—	—	—	—	1A, 1PR	—	—
A&WP	3	1	22	—	—	—	—	—	—
BAR	5	1	6	—	—	—	—	—	—
B&LE	5	—	8	1	—	10	—	—	—
BN	138	24	58	5	79	—	—	5	375
CN	174	49	365	18	24	95	218	9	500
C&O	248	1	29	2	15	—	—	1	150
B&O	95	7	76	3	24	—	—	2	300
Chicago TA	7	—	5	8	145	97	—	—	—
Clinchfield	5	—	—	—	—	—	—	—	—
D&H	—	—	6	—	—	—	—	—	—
D&RGW	—	2	—	—	—	—	1PR	—	—
DT&I	2	—	2	—	—	—	—	—	—
DM&IR	5	—	2	—	—	—	—	1	50
EJ&E	77	1	67	1	—	—	—	—	—
EL	—	6	28	1	10	—	6	—	—
Frisco	41	29	20	1	6	—	—	—	—
GM&O	40	5	12	—	—	—	13	1	40
IC	153	20	337	4	38	6	—	1	100
L&HR	—	—	2	—	—	—	—	—	—
L&N	99	15	11	25	40	—	—	1	50
MEC	—	—	14	—	—	—	—	—	—
MBTA	150	—	20	—	—	—	—	—	—
MTA-LI	103	34	219	1	640	—	—	—	—
NYCTA	1,440	67	708	3	2,400	—	—	—	—
Milwaukee Road	13	1	17	—	—	—	—	—	—
MP	35	7	20	5	45	—	—	1	—
C&EI	6	3	12	—	—	—	—	—	—
T&P	27	2	11	4	60	—	1	—	—
Monon	12	1	—	—	—	—	—	—	—
Montreal UCT	5	—	6	10	33	368	—	—	—
N&W	8	4	27	2	30	25	—	—	1
NS	—	3	10	—	—	—	—	—	114
ONL	6	—	2	1	6	—	—	1	38
PGE	40	5	2	1	2	—	7	1	150
PC	—	—	—	1	99	—	—	—	60
PATH	181	4	50	—	—	—	—	—	—
Reading	10	10	10	—	—	—	—	—	12
RF&P	7	1	20	1	6	—	—	—	—
Rock Island	111	2	4	5	35	75	—	—	—
Santa Fe	120	12	—	—	—	—	—	2	—
SCL	266	26	369	8	67	6	—	1	—
Soo Line	11	7	—	—	—	—	—	—	—
Southern	71	259	148	—	—	—	—	—	50
SP	206	37	88	—	2	—	54	1	75
Toronto TC	2	—	2	2	12	12	—	—	—
UP	90	17	79	—	36	—	30	1	215
WP	15	4	50	—	—	—	6	—	—
Totals	4,032	667	2,944	113	3,854	694	335	31	2,280

Antenna—1
Passive Repeaters—2

POLE LINE CONSTRUCTION SHOWED RESURGENCE IN 1970

Railroad	Carrier Equipment — Terminals & Repeaters — Voice	Voice + Data	Data	No. of Teleprinters	No. of Computer I/O Units	No. of Data Modems	Pole Line or Cable Construction — Miles of Wire &/or Cable	Miles of Aluminum/ Copper	No. of ACI Scanners
BAR	—	—	—	1	—	—	11w	11C	—
B&LE	—	—	—	—	—	—	8w	8C	—
BN	54	—	14	14	26	69	720w, 47c	767C	6
CN	660	242	231	2,194	600	328	2,983w, 1,017c	2,972A, 10C	—
CP Rail	—	—	—	—	—	—	—	—	1
C&O	6	4	2	30	4	8	15w, 4c	14C	—
B&O	16	2	—	20	6	12	16w, 4c	13C	6
C&NW	—	—	—	8	12	18	—	—	—
Chicago TA	—	—	—	—	—	—	10c	—	—
Cleveland TS	—	—	—	—	—	—	20c	—	—
Clinchfield	—	—	—	—	1	—	—	5C	—
DT&I	2	—	—	—	—	—	—	2C	1
DM&IR	—	—	—	—	—	—	—	200C	—
EJ&E	—	—	—	—	—	—	39w, 1c	40C	—
EL	—	—	—	—	—	—	19c	60C	—
FEC	—	—	—	1	1	1	—	—	1
Frisco	—	—	—	14	—	—	80	80C	—
GM&O	8	3	—	—	—	—	6	—	—
IC	50	30	20	—	5	26	5c	—	8
LV	—	—	—	—	—	—	30	30C	—
L&N	81	—	14	240	83	—	260w, 11c	260C	2
MEC	—	—	—	—	—	—	1c	—	—
MBTA	—	—	—	—	—	—	9c	—	—
MTA-LI	14	—	—	—	—	17	5	—	—
NYCTA	400	—	—	—	—	—	73w, 8c	—	—
Milwaukee Road	—	—	—	32	3	75*	—	—	—
MP	154	—	—	—	—	—	—	568C	—
T&P	81	—	—	—	—	—	—	—	—
Monon	—	—	—	—	7	7	—	—	—
Montreal UCT	—	—	—	—	—	—	27c	—	—
N&W	2	2	2	2	—	4	50w, 11C	20A, 32C	1
ONL	130	—	22	25	2	2	10w, 11c	5A	—
PGE	60	—	—	1	—	—	1	—	—
PC	—	—	—	—	—	19	—	—	—
Reading	4	—	—	—	—	—	4	20C	—
RF&P	—	—	—	—	—	—	3c	—	—
Rock Island	8	—	—	1	—	—	—	—	—
SCL	79	—	—	2	—	—	—	225C	1
Soo Line	8	—	—	—	—	—	—	—	—
Southern	36	12	19	—	—	38	80w, 29c	80A	3
SP	675	—	75	—	10	80	—	—	2
Union	—	—	—	—	—	—	2c	—	—
UP	48	9	24	103	112	230	3c	—	1
WP	48	4	1	—	—	—	—	—	—
Totals	**2 624**	**308**	**424**	**2,688**	**872**	**934**	**5,633**	**5,422**	**33**
							4,265 wire	**2,345 Copper**	
							1,242 cable	**3,077 Aluminum**	

* Teleprinter selectors and data monitors

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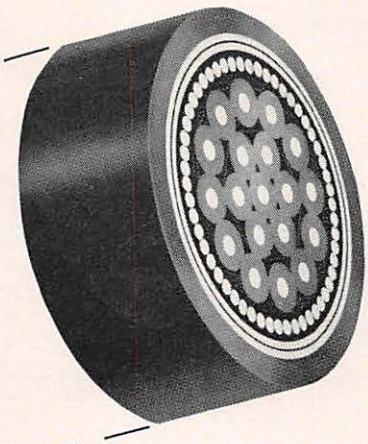

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OVER 1,500 CROSSINGS RECEIVED AUTOMATIC PROTECTION IN 1970

Railroad	Highway Grade Crossings protected by: Flashing-light Signals	Flashing-light Signals & Gates	Block Signals & Traffic Control: Road Miles	Switches	Electric Locks	Signals	Train Stops Cab Signals	Interlockings: No. of Plants	Power Switches	Signals
Alaska	5	—	—	—	—	—	—	—	—	—
BAR	5	—	—	—	—	—	—	—	—	—
B&LE	3	1	—	—	—	—	—	—	—	—
B&M	1	—	—	—	—	—	—	2	1	1
BN	32	23	131	39	53	182	—	1	4	11
CN	256	20	176	117	57	355	—	4	3	23
CP Rail	106	13	—	—	—	—	—	2	3	8
C&O	30	10	—	—	—	—	—	2	21	27
B&O	20	8	64(18ABS)	13	4	57	—	3	18	23
C&NW	38	11	—	—	—	—	—	1	3	5
C&WI	—	1	—	—	—	—	—	—	—	—
Chicago TA	—	—	5ABS	—	—	—	214cs	—	—	—
Cleveland TS	—	—	—	—	—	—	10cs	2	4	—
Clinchfield	1	—	—	1	5	4	—	—	—	—
D&H	7	—	—	—	4	—	—	—	—	—
D&RGW	5	1	6	4	17	20	—	—	—	—
DT&I	3	—	—	—	—	—	—	1	2	2
DM&IR	1	—	10ABS	—	—	4	—	—	—	—
EJ&E	1	1	—	—	—	—	—	—	—	—
EL	5	12	—	—	—	—	—	3	7	11
FEC	6	5	14	5	40	18	—	—	—	—
Frisco	18	4	—	—	—	—	—	—	—	—
GB&W	3	—	—	—	—	—	—	—	—	—
GM&O	11	2	22	3	19	18	—	1	4	—
IC	32	11	34	4	10	18	—	1	4	4
LV	3	2	19(5ABS)	—	—	10	—	3	5	13
L&N	25	3	—	—	—	—	—	1	—	—
MEC	4	—	—	—	—	—	—	1	—	6
MTA-LI	—	18	32ABS	—	3	9	470cs	1	4	5
NYCTA	—	—	—	—	—	110	27ts	2	100	53
Milwaukee Road	32	11	—	—	—	—	—	2	—	—
MP	25	5	3	—	—	4	—	—	—	—
C&EI	2	2	—	—	—	—	—	1	3	—
T&P	7	4	2ABS	—	—	2	—	—	—	—
Monon	7	—	—	—	—	—	—	—	—	—
NS	3	—	—	—	—	—	—	—	—	—
N&W	34	7	101(49ABS)	6	12	71	—	2	2	6
ONL	2	—	—	—	—	—	—	—	—	—
PGE	6	—	—	—	—	—	—	—	—	—
PC	26	55	69	26	33	101	—	9	38	40
PATH	—	—	—	—	—	—	—	2	10	21
Reading	2	2	—	—	—	—	—	3	5	12
Rock Island	32	12	55ABS	—	—	—	—	—	—	—
Santa Fe	34	49	174	—	—	—	—	—	—	—
SCL	25	17	42	31	20	64	—	2	—	8
Soo Line	37	—	48	8	5	41	—	—	—	—
Southern	35	15	9	5	1	7	—	3	7	20
SP	59	210	—	—	—	—	—	—	—	—
TRRAStL	—	1	—	—	—	—	—	1	12	14
Union	—	—	—	—	—	—	—	1	—	1
UP	18	13	9	12	2	44	25cs	—	—	—
WP	2	22	—	—	—	—	—	—	—	—
SN	1	1	—	—	—	—	—	—	—	—
Totals	**1,010**	**572**	**1,025**	**274**	**285**	**1,139**	**719cs 27ts**	**57**	**260**	**314**

PROTECTIVE SLIDE FENCING INSTALLED IN 1970 TOTALED 21,084 FT

Railroad	Detectors					Feet of Slide Fence	Electric			Miscellaneous Signal Units*
	Broken Loose-Wheel	Clearance	Dragging Equipment	Hotbox	Presence		Spring Switches	Switch Lamps	Switch Heaters	
A&WP	—	—	—	4	—	—	—	—	—	—
B&LE	—	—	2	—	—	—	—	10	5	—
B&M	—	—	—	—	—	—	—	—	—	1
BN	—	—	—	30	—	—	—	—	—	—
CN	—	—	8	9	—	—	1	—	295	31
CP Rail	—	—	1	—	—	10,874	—	—	65	54
C&O	—	—	—	—	—	—	—	—	—	3
B&O	9	—	4	9	—	—	—	—	—	—
C&NW	—	—	—	5	—	—	—	—	—	—
C&WI	—	—	—	—	—	—	—	6	—	—
Cleveland TS	—	—	—	—	—	—	—	—	17	—
D&H	—	2	—	1	—	—	—	—	6	—
D&RGW	—	—	16	2	—	10,300	—	—	4	1
DT&I	—	—	—	1	—	—	—	—	—	4
DM&IR	—	—	1	—	—	—	1	30	4	—
FEC	1	1	11	11	—	—	—	—	—	—
Frisco	—	—	4	4	—	—	—	9	—	10
GM&O	—	—	—	2	—	—	—	—	—	1
IC	—	—	14	14	—	—	—	—	—	—
LV	—	—	—	—	—	—	—	—	2	—
L&N	—	—	—	3	—	—	—	—	—	1
MTA-NYCTA	—	—	—	—	—	—	—	—	192	33
Milwaukee Road	—	—	—	—	—	—	—	—	1	—
MP	—	—	—	—	—	—	—	—	9	—
N&W	2	—	—	2	—	—	—	—	8	42
ONL	—	—	4	4	—	—	—	—	—	—
PC	—	—	—	12	—	—	—	—	—	54
PATH	—	—	—	—	—	—	—	—	—	1
Reading	—	—	—	—	—	—	—	—	12	—
RF&P	—	—	1	1	—	—	—	12	—	1
Rock Island	—	—	—	—	—	—	2	—	—	—
Santa Fe	—	—	—	5	—	—	—	—	—	—
SCL	—	—	19	19	—	—	1	—	2	20
Southern	—	2	5	7	—	—	—	—	—	4
SP	1	—	—	1	—	—	5	—	6	39
Union	—	—	—	—	—	—	—	—	53	1
UP	—	—	—	4	—	—	—	—	—	—
WP	—	—	—	1	—	—	—	—	—	—
Totals	**13**	**5**	**90**	**151**	**—**	**21,084**	**10**	**67**	**681**	**301**

* Includes retarders and power switches in yards, electric locks in interlockings, etc.

How to make crossing signals

BY VICTOR L. LINDBERG
SCIENTIFIC RESEARCH STAFF
FORD MOTOR COMPANY

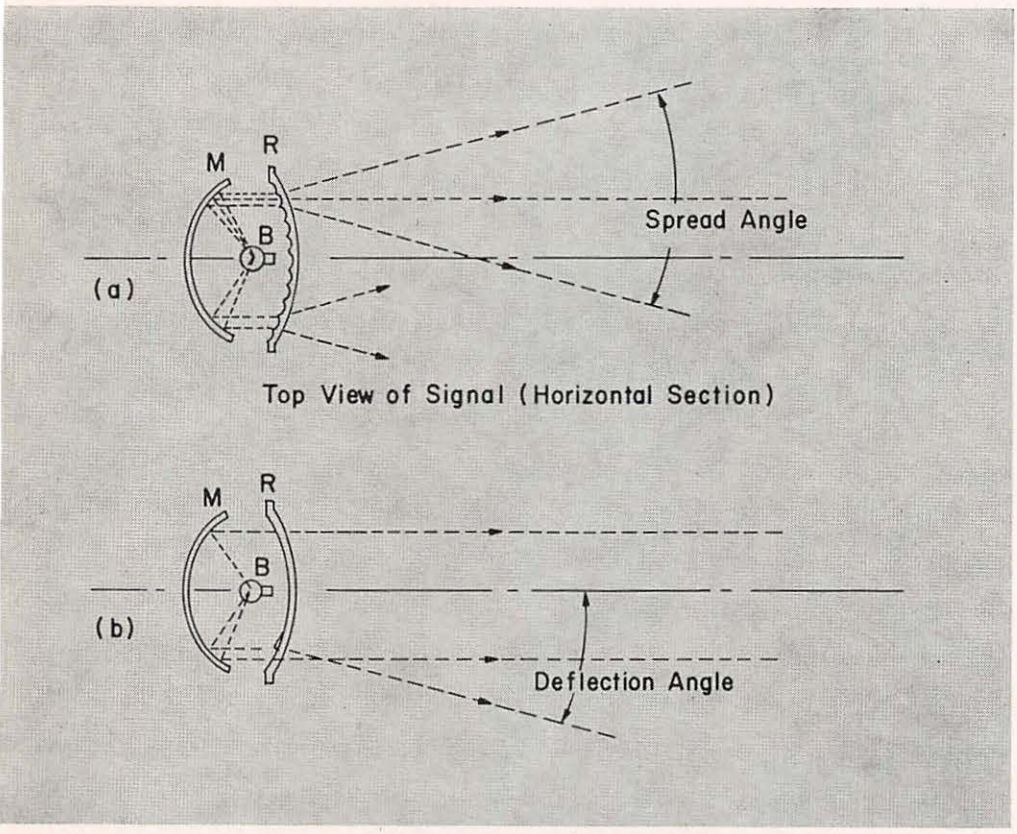

FIG. 1—Schematic shows optics of a typical crossing signal.

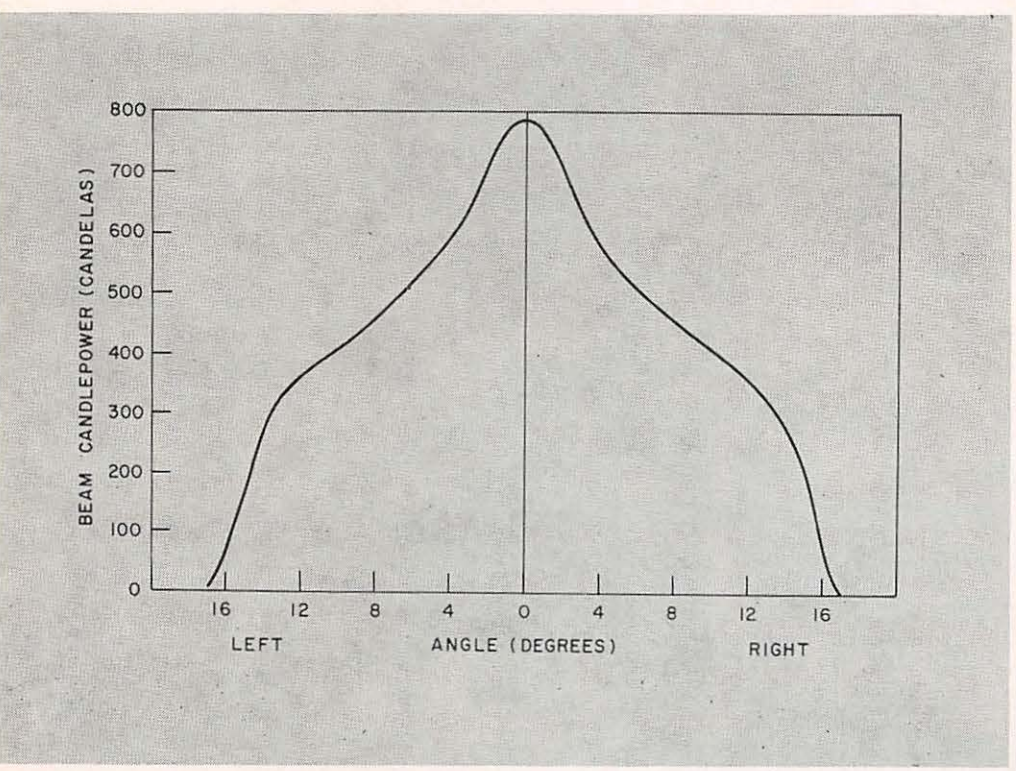

FIG. 2—Typical horizontal beam profile for 30-15 roundel.

Approximately one-third of all accidents that occur at highway crossings occur at crossings protected by flashing-light signals. In how many of these did the driver fail to see the flashing light? Unfortunately, it is very difficult to obtain this type of statistical information, and we may never have a reliable answer to this question. One can assume, however, that some of these drivers did not see the signal, and therefore, a more conspicuous signal would be a safer signal. Human engineers have taught us that one way to make a signal more conspicuous is to make it brighter.

Figure 1 shows in schematic form the optics of a typical railroad crossing signal. Light is emitted by the filament in bulb B. Typically, this is an 18-watt, S11 bulb operating at an output of about 25 candlepower. Usually, the collimating element in a signal is a glass parabolic mirror, M, silvered on the back side. Since the filament of the bulb is placed at the focus of the mirror, the light rays reflected from the mirror are essentially parallel. This means that the beam projected by the mirror with no lens in position is ideally the same diameter as the mirror anywhere along the path of the beam. In actual practice this is not quite true. The beam has only about 2 deg. of divergence and is most impressive as a spotlight.

In the horizontal section of the signal (Fig. 1a) the lens, or roundel, consists of small cylindrical elements which diverge the light into a broad horizontal fan. This is the "spread" of the signal. As shown in the vertical section (Fig. 1b) the main portion of the lens does not deviate the beam up or down. The divergence of the beam in the vertical is mainly that small amount produced by the mirror (2 deg). Small prismatic elements are often placed on the inner surface of the lens in order to deflect some light downward. The purpose of these prisms is to direct more light to the motorist who is close to the signal. These account for 20% to 25% of the total area of the lens and typically have a downward deflection angle of 15 deg.

The most common signal in use at crossings today is one in which the horizontal spread angle is 30 deg and the vertical deflection angle is 15 deg.

more observable to drivers

There are several variations other than that shown in Figure 1 for the arrangement of the optical elements in a signal. Figure 1 shows the base of the bulb mounted forward or along the axis of the mirror. With this bulb position the manufacturer has the choice of having the long dimension of the filament either vertical or horizontal. There are advantages for either position. A vertically oriented filament will give a larger vertical divergence angle to the beam but will be difficult to adjust in the horizontal (right and left) direction. A horizontally mounted filament will give a brighter beam that is narrower vertically and will be difficult to adjust in the vertical (up and down) direction. Another common position of the bulb is base up. In this case the filament is usually oriented so that the long dimension is coaxial with the reflector. This makes it easier to adjust the focal position (in and out along the axis), but difficult in the horizontal and vertical directions. With this bulb position small irregularities in the surface of the mirror do not produce dark areas in the appearance of the signal as viewed from a relatively short distance.

During the period of 1966 to 1968 an Ad Hoc Committee from Committee D (Communication & Signal Section, AAR) studied the various signals then available to the railroads. Task Group I of this committee had the assignment to conduct tests on reflector type light units using all the roundels, reflectors and bulbs which were on the market at that time. Most of these tests were conducted at the AAR Research center in Chicago.

The results of these tests were included in their report of 1968. Figure 2 is a typical horizontal beam profile for a 30-15 roundel. This is the horizontal intensity distribution of the beam through the axis of the signal. Beam candle power is defined as the luminous intensity, expressed in candelas,* of the light in a particular direction. The beam shown in Figure 2 has a peak intensity along the vertical axis of 785 candelas. If one arbitrarily defines the limit of the beam as that point at which

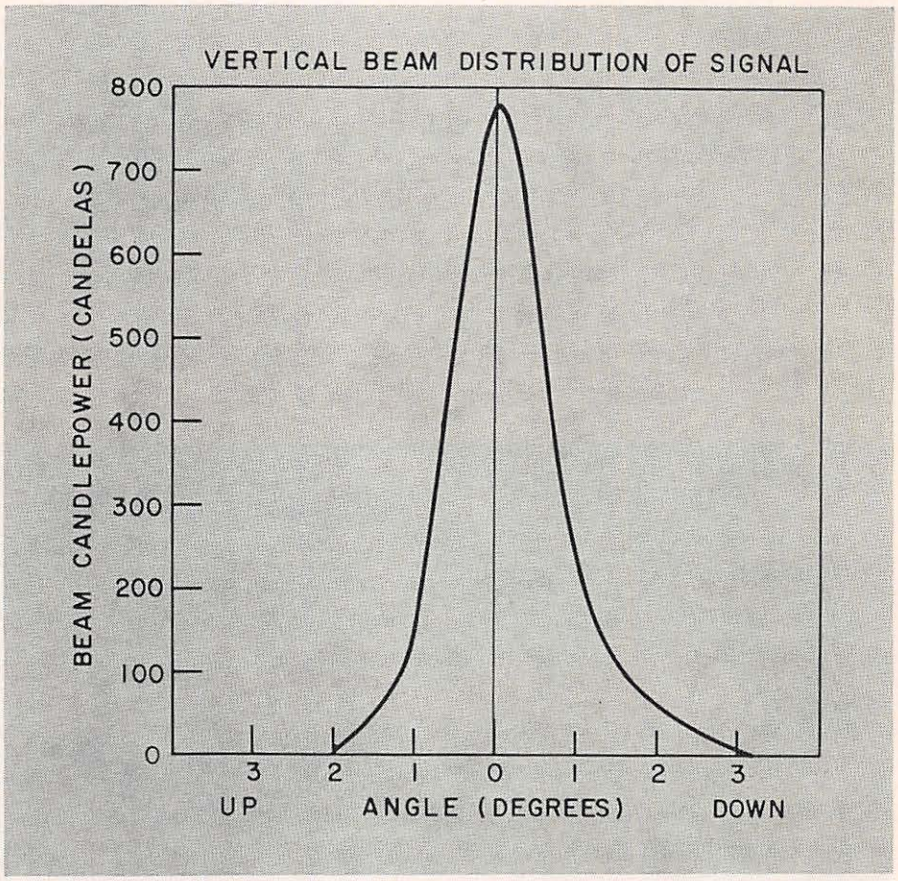

FIG. 3—Vertical beam candlepower distribution of 30-15 roundel.

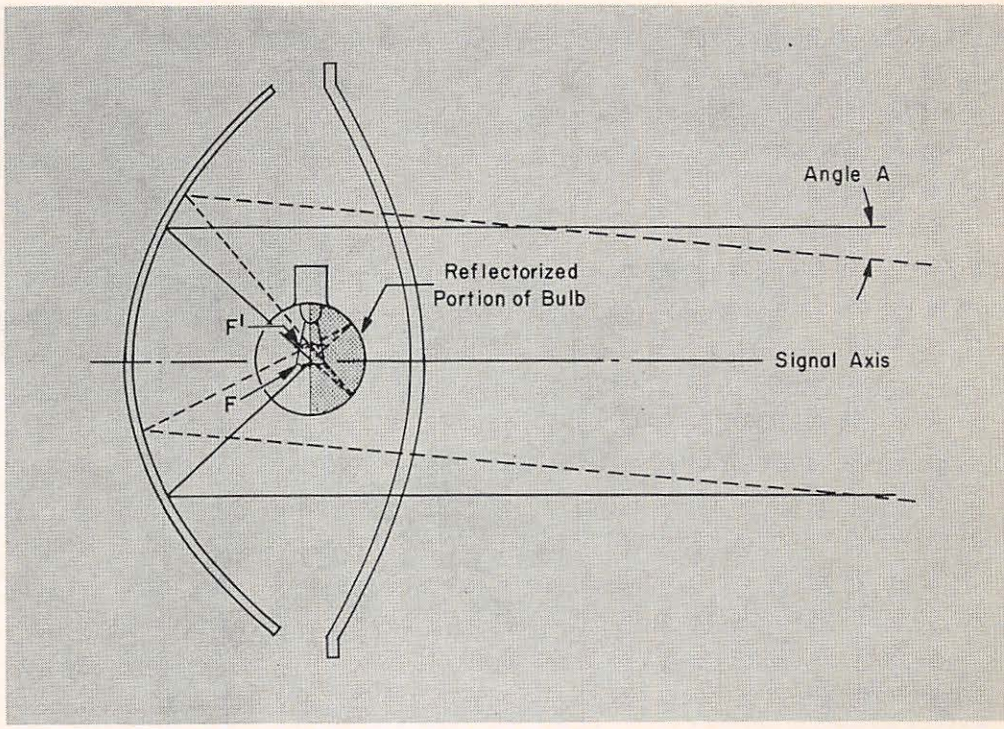

FIG. 4—Diagram shows crossing signal with a reflectorized bulb.

Candela is the luminous intensity of 1/60 of one square centimeter of projected area of a black body radiator operating at the temperature of solidification of platinum; "Illuminating Engineering Society Lighting Handbook."

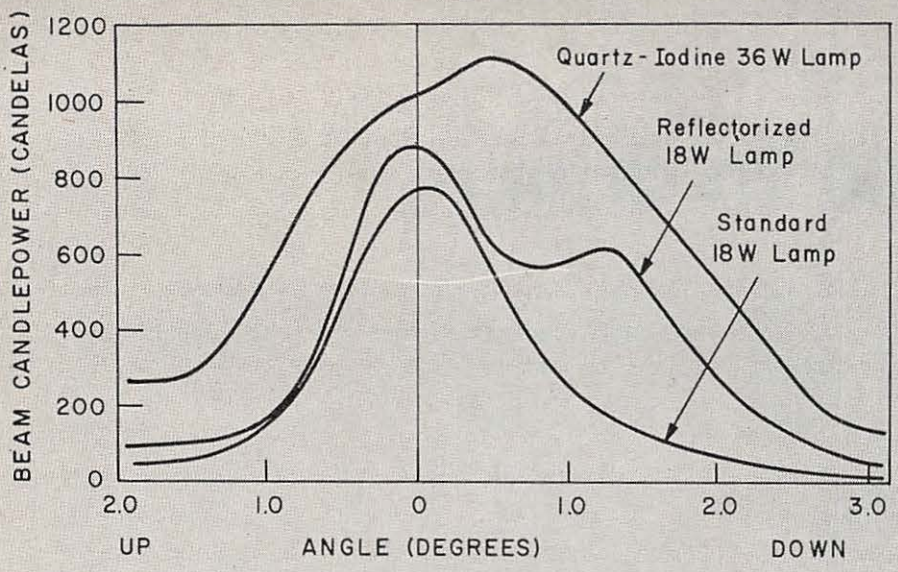

FIG. 5—Vertical beam distribution with three types of bulbs.

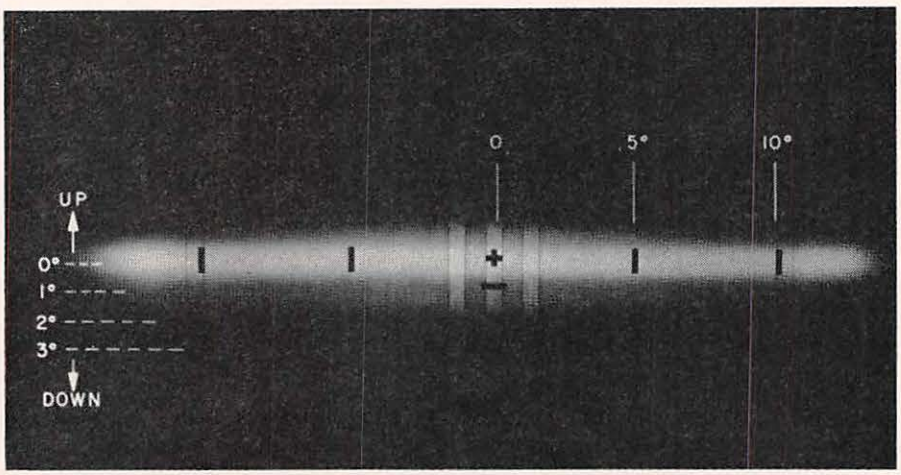

FIG. 6—Crossing signal beam pattern on a vertical surface.

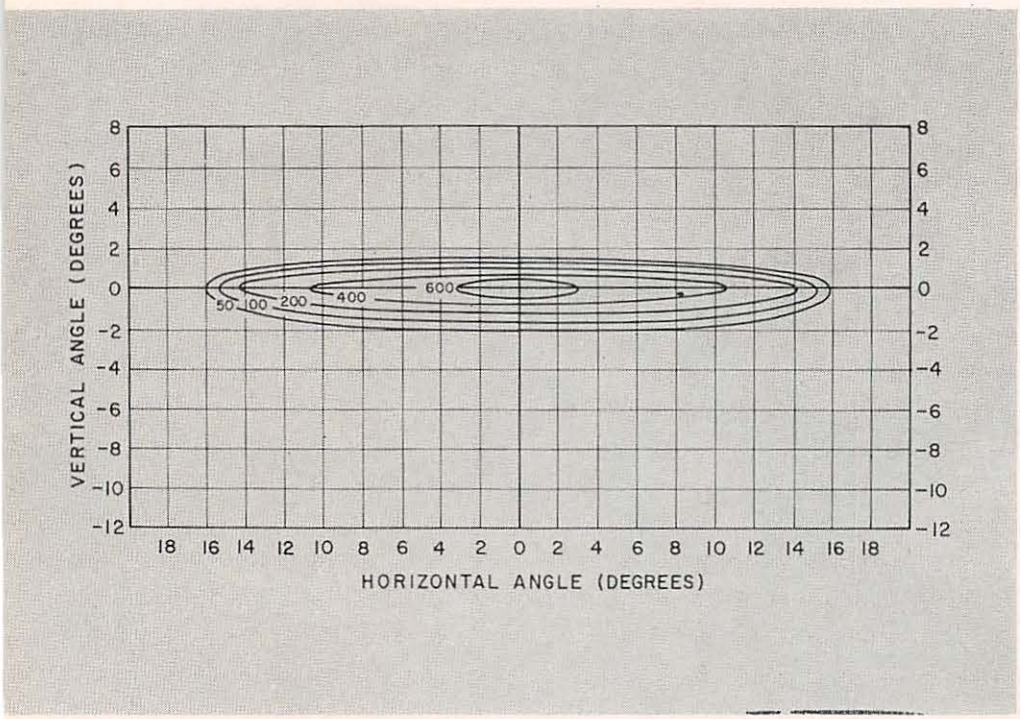

FIG. 7—Isocandela beam pattern of a typical 30-15 roundel.

the intensity falls to 10% of the peak intensity, this beam extends to 15.9 deg either side of center. Figure 3 shows the vertical beam candlepower distribution of the same signal. The limits of the beam are at 1.3 deg. in the upward direction and 1.8 deg. downward. This signal has the prismatic elements on the roundel and this is the reason for a greater divergence downward than upward.

The minimum brightness necessary for a flashing red signal to be detected in daylight has not been accurately determined. It seems that it probably lies between 100 and 400 candelas for a lamp the size of a crossing signal. This means that at some specified distance from a crossing the approaching drivers can enter an area of the signal beam where detectability of the signal becomes more difficult—especially under adverse conditions, such as sunlight on the face of the signal.

Two new light bulbs were developed during the time that the Ad Hoc Committee was conducting its study. The first of these was the reflectorized bulb. This bulb, shown in Figure 4, collects light that would ordinarily go directly out through the lens and redirects it back to the reflector. This light then becomes part of the controlled beam of the signal. The envelope of the bulb is reflectorized (that is, coated with a metallic reflector such as aluminum or silver) over the forward portion of its spherical envelope. The center of curvature of the glass envelope is located slightly above the filament. This means that an image (F′) of the filament will be produced in space near to, but above, the actual filament, F. This image also acts as an emitter of light and produces a beam similar to, but displaced downward from, the main beam of the signal.

Figure 5 shows the vertical beam distributions of a signal for both a standard 18-watt bulb and a reflectorized 18-watt bulb. The secondary peak at 1.3 deg is the middle of that portion of the beam produced by the image of the filament. At angles between 1.0 and 1.5 deg down, the intensity is about four times that of the standard bulb signal. The approaching driver is 1.3 deg below the beam axis when he is 150 ft from the crossing. It should be emphasized that small angular differences in the beam are most significant. For instance, an approaching driver moving from 300 ft to 200 ft goes through 0.5 deg of the signal beam. The most important advantage of this bulb is that no additional power is required for a significant gain in beam intensity and total light output.

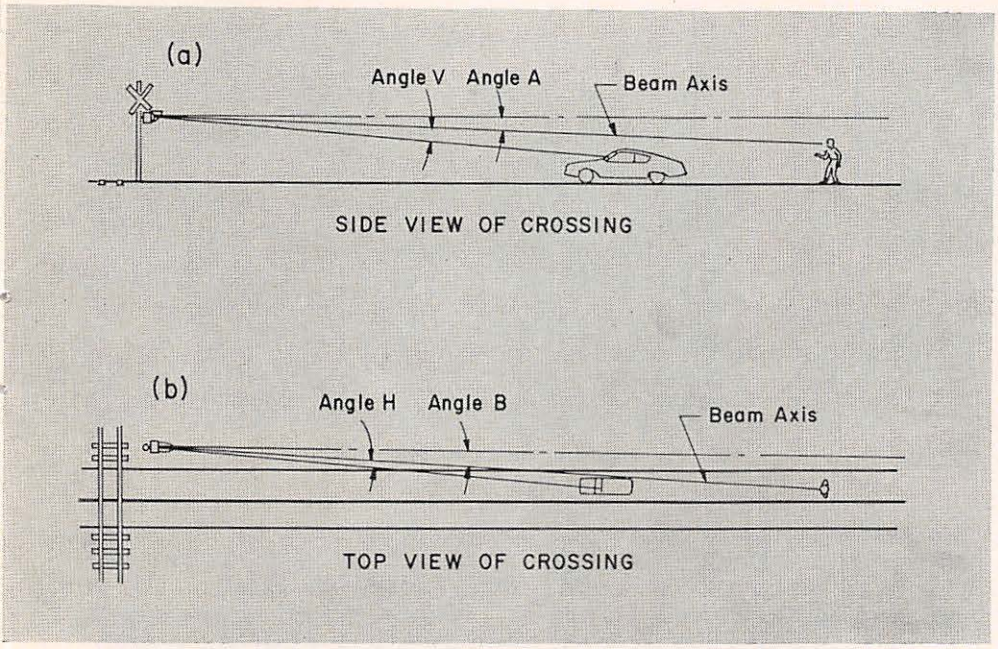

FIG. 8—Diagram shows side view and top view of a crossing.

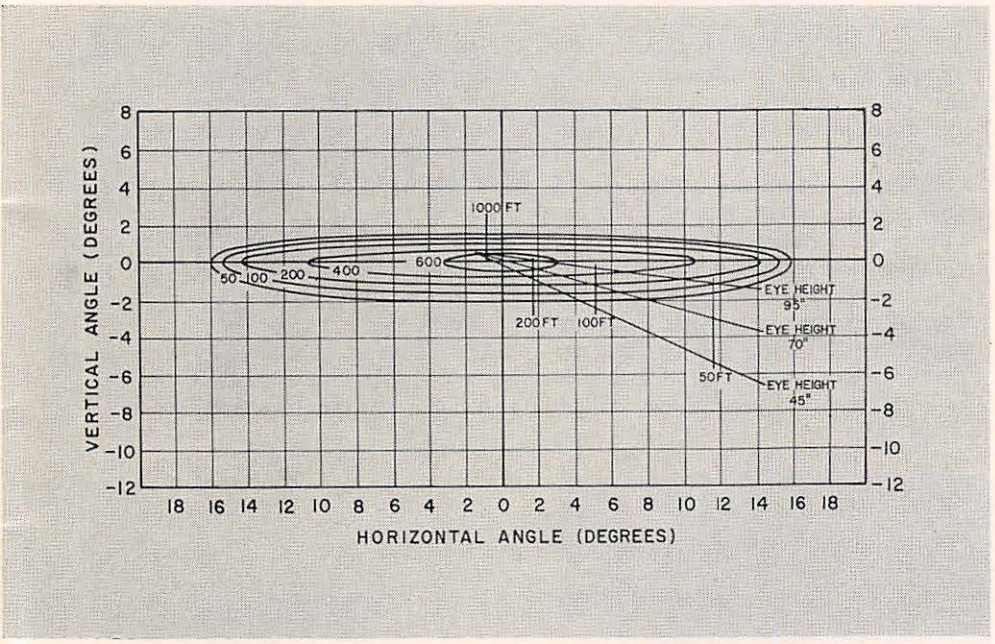

FIG. 9—Driver eyeline on 30-15 signal isocandela beam pattern.

Of course, this bulb can only be used in a signal with the proper base position. The two designs which have been used require either a base-up mount or a base-down mount.

Another new bulb which has been developed is the quartz-iodine bulb. This bulb operates at 36 watts and has a luminous output of about 90 candlepower. The life of a quartz-iodine bulb is generally longer than that of a standard bulb, and its luminous output is maintained at a high level right up to the time of burnout. Standard bulbs have a significant loss of brightness before burnout. The vertical beam distribution of a signal using a quartz-iodine bulb is also shown in Figure 5. The increase in beam intensity is significant at all positions in the beam. It would be preferable that this bulb be used only in equipment and installations specifically designed for the additional power requirements. With no additional battery capacity, standby time would be reduced to one-half that for an 18-watt bulb.

If a signal beam is directed toward a distant wall or screen it is easy to see the beam distribution pattern on the flat surface (Figure 6). If a photometer is held in the beam it will read, with the proper correction for distance, the luminous intensity of the beam at that point. If now the photometer is moved parallel to the screen in such a direction that the intensity reading remains the same, it will trace a line of equal intensity. This line of equal intensity is called an isocandela line. If an isocandela beam plot is made of the typical 30-15 signal shown in Figures 2 and 3 it will appear as in Figure 7. The lines of equal intensity, or isocandela lines, for 600, 400, 200, 100 and 50 candelas are shown. In this diagram the abscissa is the angle from the beam axis in a horizontal plane and the ordinate is the angle from the beam axis in the vertical plane. The 50 isocandela line for this beam extends to 16 deg either side of the axis, 1.5 deg up and 2.0 deg down.

If the position of the driver's eyes relative to the axis of the signal beam is known, the brightness of the signal as seen by the driver can be determined. Figure 8 shows a side view and top view of a crossing. The axis of the signal is aimed at the eye height of a man standing in the center of the approach lane. A common distance chosen for aiming is 400 ft. This procedure depresses the beam by angle A below the horizontal, as shown in figure 8a. It also rotates the beam by an angle B away from a line parallel to the road as shown in 8b. Once the aiming procedure is finished the signal beam is fixed relative to the road. The only variable now is the position of the driver's eye along the road. (For this analysis it is convenient to think of the driver as having only one eye.) The angle H and the angle V of the driver's eye in the signal beam will vary depending on the driver's distance from the crossing. Mathematically the coordinate system of the road, containing the position of the driver's eye, can be made to coincide with the coordinate system of the signal. One now knows the position of the driver's eye in the signal beam.

Figure 9 shows the path of the driver's eye through the signal beam superposed on the isocandela plot for a 30-15 signal. The conditions for the calculation of the driver's eye position are as follows: (1) Road is straight and level. (2) Two lane highway with 12 ft wide lanes. (3) Signal is 9 ft above road. (4) Signal distance from edge of pavement is 6 ft. (5) Aiming distance is 400 ft.

The 45" eye height as shown in Figure 9 is typical of an American-made, standard-size car. Large trucks and busses can have driver's eye

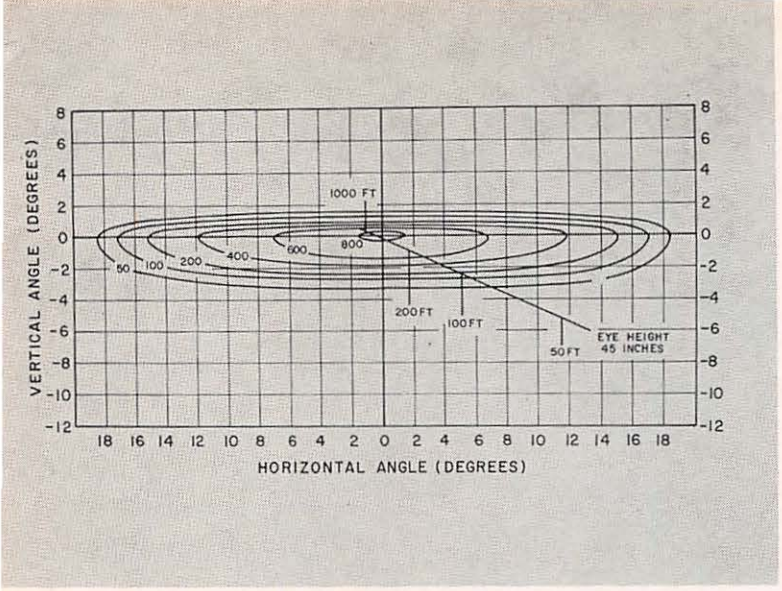

FIG. 10—Reflectorized bulb beam pattern (30-15).

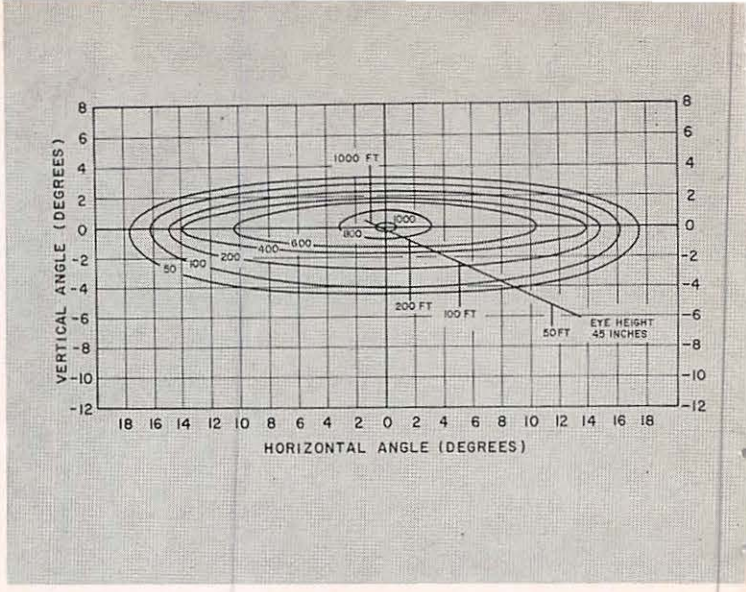

FIG. 11—Quartz-iodine bulb beam pattern.

heights of over 100". When at a great distance from the signal, say 1,000 ft, the driver is to the left and above the center of the beam. As he approaches the crossing his eye position will follow a line which goes down and to the right of the beam axis. For the signal beam shown, all drivers, regardless of height above the road, will see an intensity of 600 candelas at 1,000 ft. The automobile driver (45" height) will proceed along a line which will have an intensity of 200 candelas at 200 ft and less than 50 candelas at 100 ft. For this case the driver does not go through the center of the beam. He crosses the 100 candela intensity line at 175 ft from the crossing.

It should be noted that for a specified distance from the signal, the horizontal angle is the same for all driver eye heights.

An isocandela beam pattern diagram for a 30-15 signal using a reflectorized bulb is shown in Figure 10, along with the driver eyeline for a 45" eye height, Since more light is directed into the beam all the isocandela lines are larger. The driver eye line remains the same as before since the only change is the signal beam. The eyeline now crosses the 100 candela line at 5.6 deg to the right and 2.6 deg down, which corresponds to a driver distance of 95 ft. This is 80 ft closer to the crossing than is the case for the signal with the standard bulb.

Figure 11 shows the pattern for a signal using a quartz iodine bulb. Because of the greater input power and higher efficiency, the space enclosed by the isocandela lines is broader than for either of the previous signals. For comparison, the 100 isocandela line and the driver eyeline intersect at 8.2 deg to the right and 3.4 deg down, which corresponds to a distance of 68 ft from the crossing. This is 107 ft closer than with a standard bulb signal.

Two new roundels have recently been introduced which are certainly beneficial in directing more light to where the driver is apt to be in the beam. Figure 12 shows the beam pattern of the No. 68-101 roundel used in a signal with an 18-watt bulb. In this case the signal was aimed at a point 6 ft off the edge of the roadway according to the manufacturer's recommendations. The intensity falls below 100 candelas when the driver is at 110 ft from the crossing. It should be noted, however, that the beam intensity approaches, 2,000 candelas at 300 to 400 ft from the railroad-highway grade crossing.

The beam of another new roundel, No. 5357, shown in Figure 13, also has a high, 4,000 candela intensity near

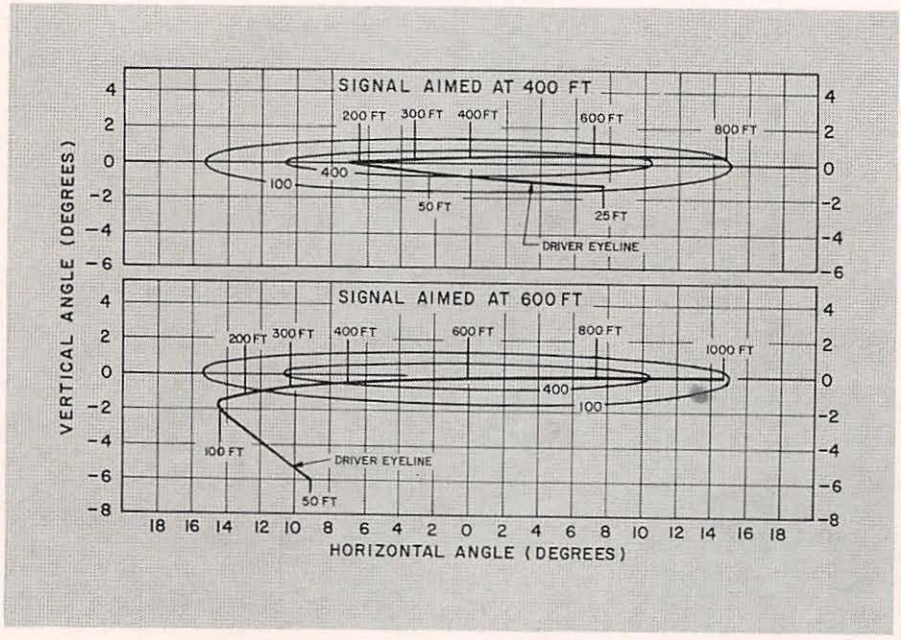

FIG. 14—Beam pattern (3015) driver eyeline (45"), 700 ft curve.

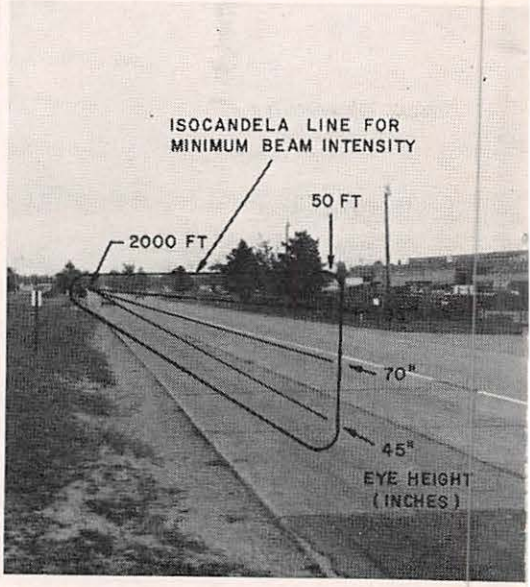

FIG. 15—View of the highway from the crossing signal.

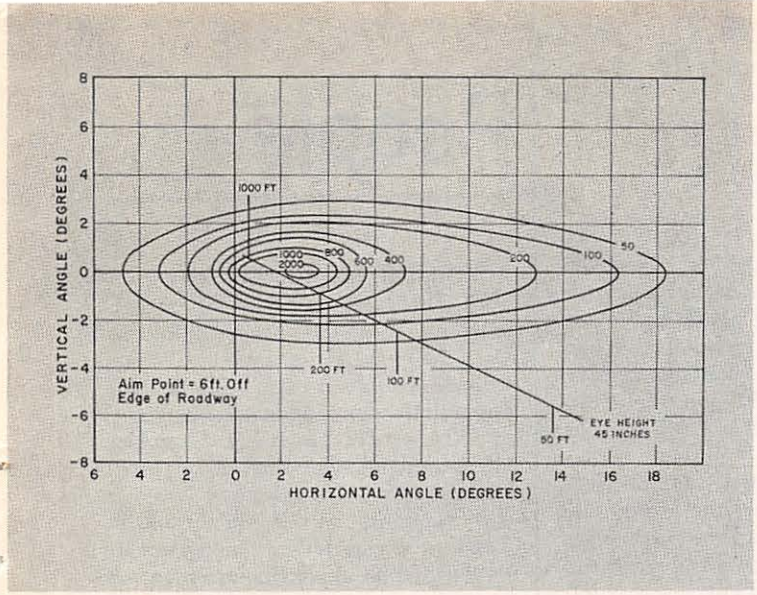

FIG. 12—Beam pattern of 68-101 signal.

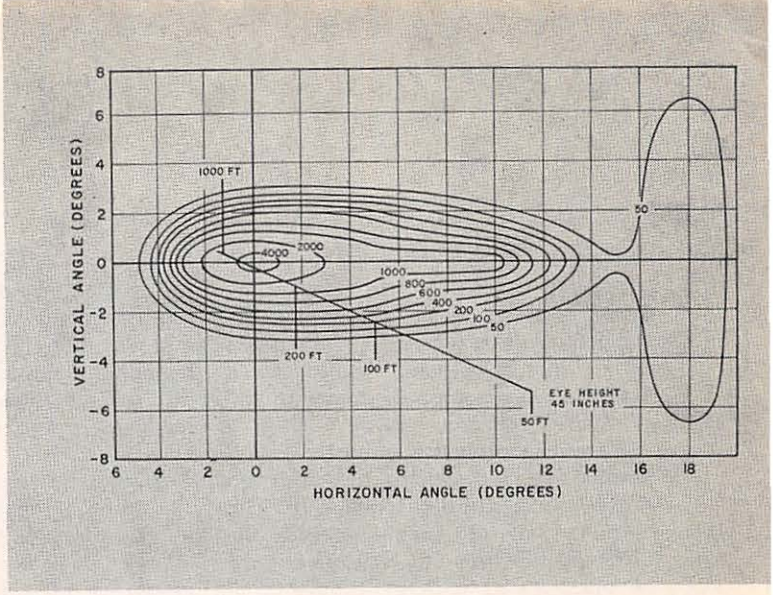

FIG. 13—Beam pattern of No. 5357 signal.

the beam center. The driver eyeline crosses the 100 candela line at 95 ft in this case. If either the driver eye is higher or the signal is farther off the road, the driver eyeline in both this and the previous signal (68-101) would go through a brighter portion of the beam, that is, the eyeline would be closer to the horizontal axis of the signal.

As can be seen from the isocandela beam diagrams, both of these signal beams are symmetrical about the horizontal axis. This property makes them useful for mounting on either the right or left side of the road. Since both deflect the beam to the right, care must be taken for proper aiming if mounted on the left side of the road.

So far the driver eyeline has only been presented for the conditions which represent a straight and level road. Figure 14 shows what happens when there is a curve in the road. This figure shows the driver's eyeline in a 30-15 signal beam and for a curve of 700 ft radius that ends at the crossing, so that the angle between the road and the track is 90 deg. The distance to the alignment point and the distance to the driver are measured along the curve of the road, not as the shortest distance to the signal. The top figure shows the driver's eyeline for an alignment distance of 400 ft. In this case the driver does not enter the area where the intensity is greater than 100 candelas until he is 800 ft from the crossing. On the other hand, it should be pointed out that he remains in this area to within less than 25 ft from the crossing. If, however, the signal is aimed at 600 ft, as shown in the bottom figure, he enters this area at more than 1,000 ft and leaves at about 150 ft. The choice of aiming distance in this case would have to be decided on factors other than the signal beam. Such things as how many signals at the crossing, traffic speed, and traffic density would be some of the conditions to be considered.

It is evident that in order to attain the optimum signal beam for any given set of conditions a systems design approach must be taken. The first and primary consideration in the design of a crossing signal is to prevent a signal to the approaching driver which will positively alert him that a train is approaching. Unfortunately, there are many unanswered questions as to the optimum signal which would perform this task. The flash rate, the signal size, the signal intensity, the signal shape, the signal position, the signal color, and the background illumination are some of the conditions which have to be optimized to make a "perfect" signal. All these things have been considered to some extent in the de-

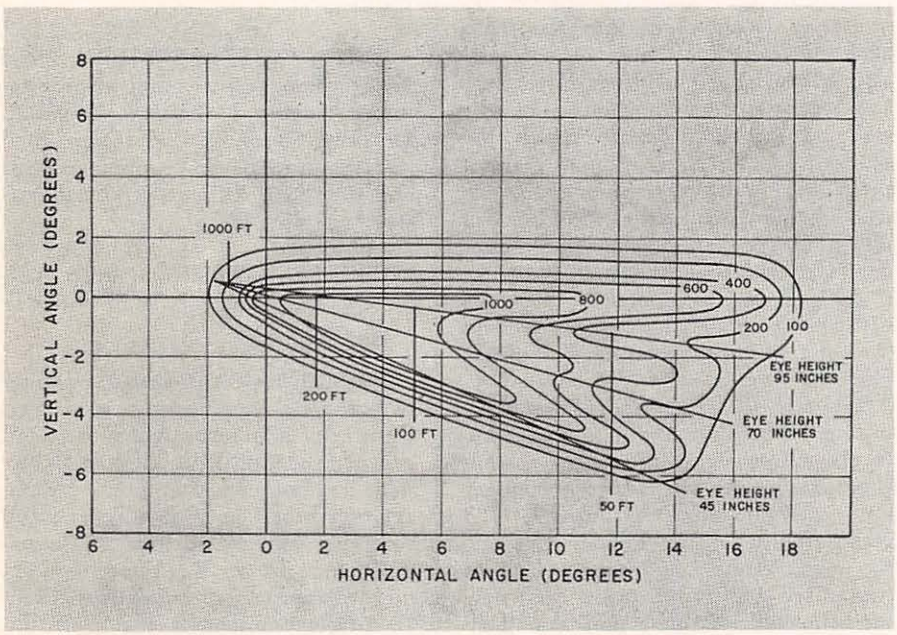

FIG. 16—Isocandela beam pattern of a multiple beam signal.

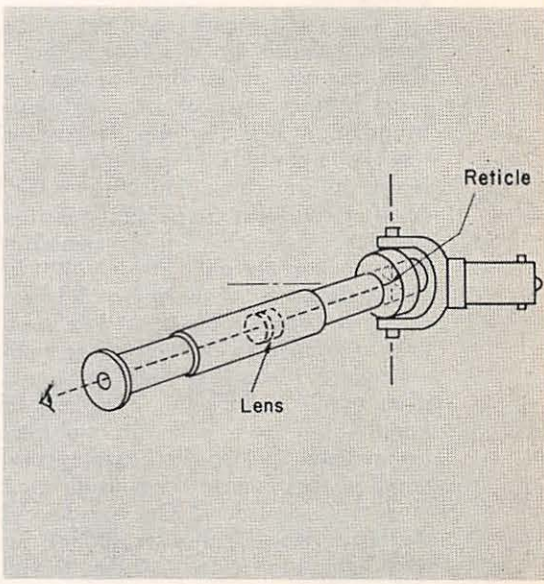

FIG. 17—Signal alignment device is 10-power microscope.

velopment of the present signal systems, and it would be surprising to see drastic changes in signals as new developments take place. As pointed out earlier, however, any change which makes a signal more conspicuous will also make it safer.

Once the optimum intensity is determined a beam must be designed which will produce this intensity. The optimum intensity may vary with the distance, however, so that what may be optimum at a long distance from the crossing will not necessarily be optimum at shorter distances. The design of the bulb, the reflector, and the lens must be such that the desired beam pattern is attained.

An effort has been made to use this approach in the design of a signal beam to be used on a relatively straight and level crossing and mast-mounted on the right side of the road. As can be seen from Figure 9, the possible driver eye positions for most cars and trucks are contained in a triangular space which broadens to the right of the vertical axis. Figure 15 is the view from the signal position of a road approaching a crossing. Three driver eyelines are drawn which correspond to 45", 70" and 95" eye height and include approach distances of 2,000 ft to 50 ft. If the desired beam was one which was to include all driver eye positions up to 50 ft and have a certain minimum intensity for all these positions, then the isocandela line for this minimum intensity would have the approximately trangular outline on the photograph.

Using this isocandela outline as the basis for the design of a lens, a prototype lens was made which produces a beam with approximately this light distribution. A basis for the design was that the intensity be at least 400 candelas at all points within the outline. Another condition for design was that the signal using this lens be aimed at the common aim point, that is 400 ft, and at the center of the approach lane.

Figure 16 shows the isocandela beam pattern using this prototype lens with a standard 18-watt bulb and a silvered glass parabolic reflector. The lens or roundel has been called a multiple-beam roundel, since the beam is composed of three separate beams directed in specific directions. One portion of the beam, which comprises 40% of the total light, is deviated 7.5 deg to the right and then spread into a 15 deg wide beam. The shape of the other two portions of the beam are similar to the first. Their positions, however, are rotated about the signal axis (the aimed direction of the signal) by 11 deg and 22 deg, respectively. The lower beam (22 deg rotation) contains another 40% of the total light and the intermediate beam contains 20% of the total.

It must be emphasized that this lens can only be used on the right side of the road. It would be ineffective when used on a cantilever overhead mount or as a backlight on the left side of the road. The same method for a design, however, can be used to design an optimum signal for either of these two positions.

Effectiveness of a signal has always been very dependent on proper aiming. In many cases there might be some allowance for aiming error since some signals have a broader beam than that which actually is needed to cover the road. With the development of narrower, more closely controlled beams it becomes more important that aiming be as accurate as possible.

There have been two new methods of aiming which hopefully will produce a higher accuracy in aiming of signals. The first method uses a radio tone to tell the adjuster when the signal is properly aimed. This device, when placed at the desired aim point, senses the intensity of the light beam and transmits this information to the adjuster by radio.

Another aiming method makes use of the optical imaging properties of the parabolic reflector. This device, shown in Figure 17, is a 10-power microscope which plugs into the lamp socket in place of the lamp. A cross-line reticle, which is observed through the microscope, is positioned at the precise location in space which the filament of the lamp ordinarily occupies. With a target positioned at the desired aim point, the signal is in alignment when the image of the target coincides with the cross line.

Both of the above methods have the distinct advantage that the man doing the adjusting also determines the correct alignment.

Research in design and manufacturing methods will continue to contribute to the effectiveness of grade crossing protection until there are no longer any grade crossings to protect. The responsibility of the signal engineer, the manufacturer, and the AAR is to recognize the advantages of new methods and products and put them to use.

People

BURLINGTON NORTHERN: **Donald C. Hill,** assistant director communications, Twin Cities and Billings region, appointed assistant director communications system. **G. B. Moff** appointed senior industrial engineer at Minneapolis. **Thomas J. Lamphier,** vice-president planning appointed vice-president management services and planning, succeeding **Frank H. Coyne,** vice-president management services appointed vice-president finance.

CANADIAN TRANSPORT COMMISSION: **Roy M. McIntosh,** assistant chief signal engineer, appointed chief signal engineer, succeeding **M. M. Stonehouse,** retired. **H. H. Blakney,** signal engineer, appointed assistant chief signal engineer. Both men are headquartered at Ottawa, Ont.

CHESAPEAKE & OHIO/BALTIMORE & OHIO: **George W. Kearney,** communications engineer, appointed manager communications engineering and operations at Huntington, W. Va. **Vernon R. Bailey,** signal inspector Baltimore, appointed signal supervisor Grafton, W. Va. **John J. Standish** appointed industrial engineer, Baltimore. **Kermit R. Smith,** manager of systems planning, appointed manager data systems standards at Baltimore.

CHICAGO & NORTH WESTERN: **Richard P. Hoffman** engineering analyst, train accident prevention, appointed manager train accident prevention.

ELGIN, JOLIET & EASTERN: **Floyd M. Harris** appointed supervisor communications and electrical. **David E. Doty** and **Charles J. Egdorf** appointed assistant supervisors communications and electrical. All men are headquartered at Joliet, Ill.

ERIE LACKAWANNA: **Paul S. Lefler** appointed general signal inspector at Marion, Ohio.

FRISCO: **Jack A. Bellman,** manager of industrial engineering, appointed director of administrative systems and procedures. **Emil J. Isenberg,** manager data systems and computer services, appointed director of data systems and computer services. **Richard A. Hagenhoff** and **Dean R. Vierrether** appointed managers-data systems. **Clark E. Martin** appointed manager-computer services.

Donald C. Hill
Burlington Northern

Charles F. Quinn
McGraw-Edison Co.

Robert E. Heggestad
Harmon Electronics

Larry R. Long
Harmon Electronics

Richard A. Mather
Harmon Electronics

Walter G. Roth
Western-Cullen

ILLINOIS CENTRAL: Robert W. Hunsley, signal foreman, appointed supervisor of signals at Chicago. G. B. Newman, supervisor of signals, Paducah, Ky., retired.

LOUISVILLE & NASHVILLE: James T. Brown, signal inspector, Louisville, Ky., appointed signal supervisor, electronics. Victor R. Stansberry, Sr., signal inspector appointed signal inspector, electronics. Edgar Lee Turpen, Jr., Peter A. Schulze, John Winner and Albert W. Lewis appointed industrial engineers. All will be headquartered at Louisville.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY: Joseph C. Kelly, acting general manager, appointed general manager.

MILWAUKEE ROAD: Paul V. Mather, assistant signal engineer, appointed signal engineer succeeding Gordon M. Hill who resigned to take a position with DeLeuw Cather & Co. in Washington, D.C.

ROCK ISLAND: C. James Taylor, director of economic research and cost control, appointed director of management services. E. F. Yuknis appointed signal supervisor-systems at Chicago. E. L. Hite, assistant superintendent communications appointed assistant to general superintendent communications and signals.

SANTA FE: D. M. Gaddis, traffic control system engineer at Los Angeles, appointed assistant signal engineer, Amarillo, Texas, succeeding A. L. McCune, retired. N. J. Wimmer, general signal supervisor, Los Angeles, appointed traffic control system engineer. W. J. Disney, assistant to signal engineer, Coast Lines, appointed general signal supervisor.

SOUTHERN: William C. Conley, assistant signal and electrical supervisor, Charlottesville, Va., appointed signal and electrical supervisor at Lynchburg, Va. Wayne T. Michael appointed signal and electrical supervisor, Alexandria, Va. F. Thomas Wiley, Jr., assistant signal and electrical supervisor, Gainesville, Ga., appointed signal and electrical supervisor there. Kenneth E. Starling, director special projects, appointed director systems development, Atlanta. Howard H. Sproles, Jr., appointed data reporting supervisor, Atlanta, Ga. Arthur L. White, Jr. appointed assistant district signal and electrical engineer, Somerset, Ky. E. Earl Seal appointed director industrial engineering, management information services, Atlanta. Arthur J. Bedinghaus appointed communications traffic supervisor, Washington. Marvin W. Holt appointed supervisor communications, Sheffield, Ala.

Suppliers

FEDERAL SIGN & SIGNAL CORP.: Richard L. Tannehill appointed vice president and general manager of the Western-Cullen Division at Chicago, succeeding A. A. Wright who will have corporate special assignments.

HARMON ELECTRONICS INC.: Robert E. Heggestad, design engineer communications and signals, Penn Central, appointed vice president research and development. Larry R. Long, coordinator of sales training, Beech Aircraft Corp., appointed director of marketing. Richard A. Mather, marketing engineer crossing protection, Signal & Communications Div. WABCO, appointed crossing signal engineer. All will be headquartered at Grain Valley, Mo.

ITT COMMUNICATIONS EQUIPMENT & SYSTEMS: Edgar G. Grant appointed president.

THE KERITE CO.: Robert A. Olson, assistant western manager, power and industrial division, appointed Pacific Coast manager, with headquarters in San Francisco. T. J. Deimer, sales representative, appointed assistant western manager, power and industrial division, with headquarters in Chicago.

LENKURT ELECTRIC CO. INC.: Robert N. Weems, engineering technician, Collins Radio Co., appointed assistant sales engineer, Dallas, Tex.

McGRAW-EDISON CO., Edison Battery Div.: Charles F. Quinn, field engineer, appointed assistant district manager with headquarters in Pittsburgh, Pa.

RAILROAD ACCESSORIES CORP.: Joseph Aldern, general sales manager, appointed assistant to the president. Eugene R. Zebe, vice president Chicago division, Marquardt Industrial Products Co., appointed vice president sales, RACO, and will maintain his headquarters in Chicago. The present sales staff of RACO and MIPCO are consolidated and will report to Zebe. W. B. Clinton, former engineer signals and communications, Detroit, Toledo & Ironton, appointed sales and service representative for the St. Louis area.

UNION CARBIDE CORP., Carbon Products Div.: Robert G. Russel, director of marketing, appointed vice president marketing.

WESTERN-CULLEN DIV., Federal Sign & Signal Corp.: Walter G. Roth, sales manager communications equipment, recently retired, has been appointed southeastern U.S. sales agent for Western-Cullen communications and signaling equipment. His address: Golf View Manors, 4312 Plaza Gate Lane South, Jacksonville, Fla. 32217.

Obituaries

LEON D. DICKINSON, retired general signal engineer, Union Pacific, died Dec. 13.

C. H. JOHNSON, retired office engineer, communications and signals, St. Louis-San Francisco, died November 10, 1970.

E. BENJAMIN PLATT, retired assistant to signal engineer, Illinois Central, died Nov. 18.

LOUIS WERTHMULLER, retired signal engineer, Missouri Pacific, died December 2.

Books

Microwave book aids application engineers

A new book provides in a readily usable and practical format the basic information, principles, techniques and practices required in planning and engineering line-of-sight paths for microwave communications systems in the frequency bands between 2 GHz and 16 GHz. Emphasis is devoted to techniques and practices, but a considerable amount of theoretical discussion is provided to help the reader to understand the various phenomena which are peculiar to microwave radio transmission.

Though the volume will have its major value as a reference for communications engineers engaged in microwave path planning, it is sufficiently general to be used by readers with technical fluency.

Divided into six sections, the book provides an introduction and appraisal, discussions of microwave frequency bands, route and site selection, overall system design, equipment selection, and calculations.

Many formulas, charts and figures are included throughout the work, and listed in a table of contents as an aid in day-to-day usage. Selected formulas (both in English and metric form), charts and figures have also been duplicated in appendices.

The book was written by Robert F. White, senior staff engineer in the Lenkurt Systems Engineering.

Engineering Considerations for Microwave Communications Systems, by Robert F. White, 1970, 151 pages, Lenkurt Electric Co., Inc., 1105 County Road, Dept. C134, San Carlos, Calif. 94070. Price: $10.00 US APO and FPO; $15.00 foreign, postage included.

Book catalogue aids technicians, engineers

A 1971 technical and scientific book catalog describes over 650 hardbound and paperback books. Special sections in the catalog feature "do-it-yourself" titles, and amateur radio publications. Vocational educators and industrial training directors will find textbooks, instructor's guides and student workbooks in the section entitled "Text and Training Materials for In-Plant and Vocational Education."

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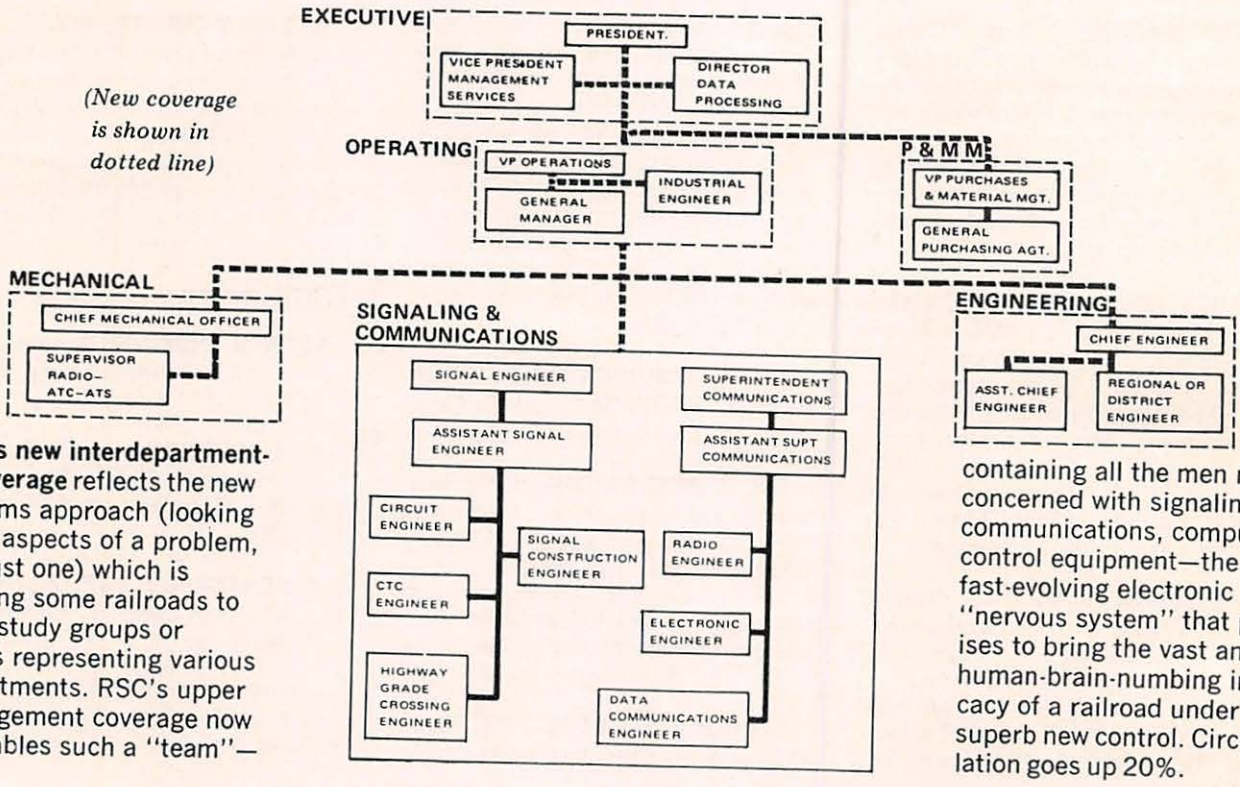

(New coverage is shown in dotted line)

RSC's new interdepartmental coverage reflects the new systems approach (looking at all aspects of a problem, not just one) which is causing some railroads to form study groups or teams representing various departments. RSC's upper management coverage now resembles such a "team"—containing all the men now concerned with signaling, communications, computers, control equipment—the fast-evolving electronic "nervous system" that promises to bring the vast and human-brain-numbing intricacy of a railroad under superb new control. Circulation goes up 20%.

News Briefs

Edison to change its corporate name

Edison Battery Division, McGraw Edison Company, is the new name for the Primary Battery Division, Thomas A. Edison Industries, headquartered at Bloomfield, N.J.

The new name was adopted, said a company spokesman, to provide a more descriptive identification with the manufacturing and marketing areas in which the division is now involved. Present products include a line of nickel-cadmium storage batteries and primary batteries.

WABCO to discontinue ACI product line

Automatic car identification systems and hardware manufactured by the Signal & Communications division of Westinghouse Air Brake Co. are to be discontinued. The ACI equipment was sold under a license from Sylvania Electric Products Inc., which held system approval from the AAR.

A number of WABCO-produced systems are now operational and others are in various stages of installation and check out. "WABCO intends to honor our obligations to customers who now have our equipment," said C. B. Ramsdell, vice-president and general manager, S&C division.

BN seeks to drop cab signals

Burlington Northern is asking the Federal Railroad Administration permission to discontinue its automatic cab signal system in the vicinity of Aurora, Ill. and on approximately 105 miles of main line between Aurora and Savanna, Ill. Also, it proposes to operate all through passenger trains without automatic cab signaling between Aurora and Chicago, approximately 35 miles. Present commuter service in the Chicago-Aurora area is operated with cab signal equipped locomotives.

BN has 65 locomotives equipped with cab signals and maintains that it cannot be economically justified to continue cab signal systems. Furthermore the cost of motive power is such that the available power must be utilized systemwide to realize maximum economy and efficiency. Accordingly, the 65 locomotives could be more efficiently operated over the entire system rather than being limited to the Aurora-Savanna and Chicago service.

Maximum speed in the territory had been reduced from 90 mph to 79 mph in which it is proposed to eliminate the cab signals. Additional-

(Please turn to page 36)

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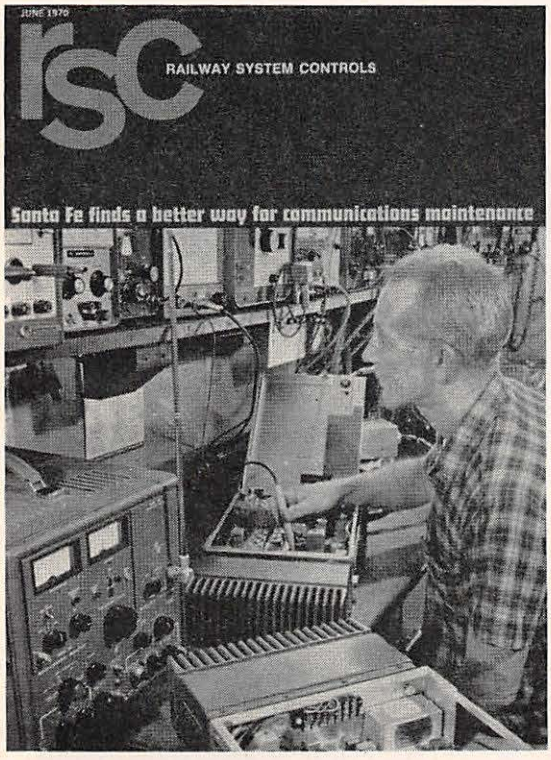

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. . .Industrial Engineering, Operating, Engineering, Mechanical, Purchasing and Data Processing are now more active in S&C areas.

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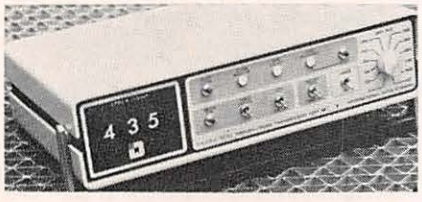
Product News

Cars counted at speeds zero to 100 mph (101)

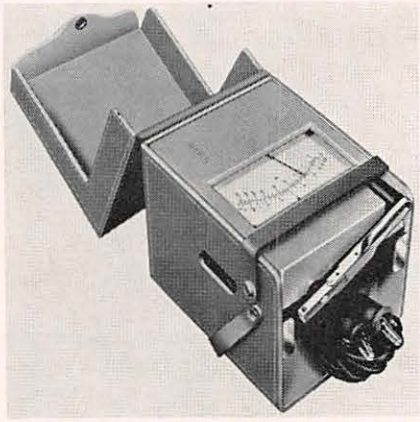
An electronic car counter (not a wheel counter) has the capabilities of counting cars at speeds from zero to 100 mph. The system operates on the principle of using the impedance of the rails between the last axle of the front truck and the first axle of the rear truck of a car. High frequency energy is connected to the track and a pair of receiver wires are connected from the same point at the track to a receiving unit. When the center of the car is over the track connection, there is sufficient impedance between the second axle of the first truck and the first axle of the second truck to enable a counting relay to respond and pick up. Contacts of this counting relay can then be used to operate a registering counter or can be connected to a computer. During the time that a rear truck of one car and the front truck of another car pass over the track connections, the counting relay is deenergized and becomes energized again when the center of a car is over the connections. The net result is that the counting system gives a count of 1 plus the number of cars. A non-moving electronic output can be provided if desirable. The system operates from 24 volts DC and uses approximately 5 volt-amp of energy. *Transcontrol Corp.*



Test set checks data transmission (102)

The Range Rider model 1100 pseudo-noise transmission test set tests both synchronous and asynchronous digital data transmission systems, modems, digital multiplexers, time sharing networks and advanced communications systems.

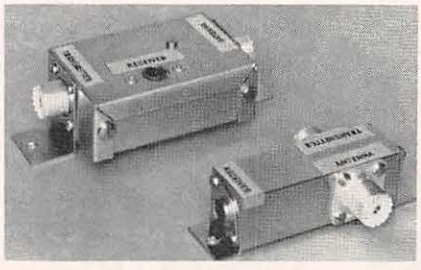
When externally timed for synchronous operation, the model 1100 is capable of DC to half megahertz operation. When internally timed for asynchronous operation, data rates selectable from a front panel control are 75, 150, 300, 600, 1200, 1800, 2400, 3600, 4800, 7200, 9600 bits per second. The unit is capable of simplex, half duplex, or full duplex operation. Additional features include automatic synchronization, self test capability, and manual error injection. *International Data Sciences, Inc.*



Insulation tester has extended scale (103)

New midget insulation testers feature an extended easy-to-read scale and self-contained hand generator so there is no dependence on batteries or other types of power. The Mark IV tester is housed in a convenient camera-type case which also contains the leads. The tester can be operated while in its case.

The MK IV tester is available in three models: 0-50 megohms and 500 ohms at 250 volts, DC; 0-100 megohms and 500 ohms at 500 volts DC; and 0-100 megohms and 10,000 ohms at 500 volts DC. *James G. Biddle Co.*



Antenna coupler handles AM and 2-way VHF (104)

A special purpose mobile antenna coupler allows standard AM (and in some cases AM/FM) broadcast receivers to operate simultaneously with a two-way radio, utilizing the existing mobile antenna.

The D-236L (30-50 MHz) and for A/M receiver coupling with a mobile frequency, and operate over the entire two-way band indicated without tuning. The D-236U (400-470 MHz) will permit AM/FM reception and operates over the entire two-way band indicated without tuning. *Sinclair Radio Laboratories.*

Small-bore coax is for carrier telephony (105)

A new design of small bore coaxial cable for short and medium haul carrier telephony is the 0.174" Bamboo-type coaxial unit. It is manufactured to include up to 18 units under one sheath and its rugged construction makes it extremely practicable for direct burial by ploughing. The 0.174" (NE-174) is suitable for use from 300 to 2700 voice frequency channels on any one pair of coaxial units or one television and 1200 maximum voice frequency channels.

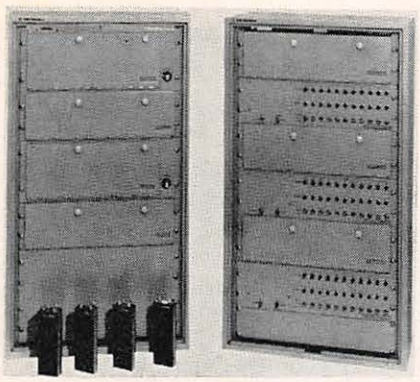
It is intended for distances of up to 1000 miles radius and can be used for medium and short haul carrier telephony, for spur runs off long haul routes and for wire line entrance links. The coaxial unit has a nominal 75 ohms impedance and is fully in accordance with CCITT recommendation G342 including the most stringent echo values for TV transmission. It has also very good structural return loss in the VHF band. *Northern Electric Co., Ltd.*

Data transmission can reach subscribers (106)

The 25B/108 extends multi-channel data or teletypewriter circuits from a type 25B data transmission system terminal to a single subscriber location. It is fully end-to-end compatible with Western Electric's 108A, 108B, and 108C private line station equipment and provides a data interface fully adhering to EIA Standard RS-232-B.

A compactly designed and attractive cabinet for the unit is suited for desk top mounting. Alternatively, the data set may be mounted in the knee-

well of a teletypewriter or on any vertical surface. Multiple channel arrangements for 19" rack mounting are also available. *Lenkurt Electric Co., Inc.*



Portables and base units give area coverage (107)

With the TAC (Total Area Coverage) two-way radio communications system, personnel equipped with portable radios will be able to communicate directly with their control center from anywhere within a city, railroad yard, industrial complex or other large area.

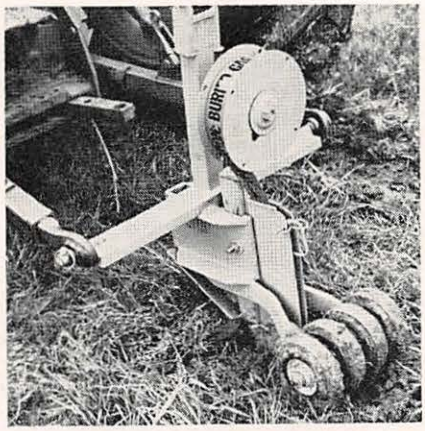
The system includes satelite receivers placed at strategic locations throughout the area and a comparator, located at the communications control center. For example, should a switchman in a large railroad switching yard transmit information to the control center, all satelite receivers in his vicinity would receive the transmission. The comparator would then automatically, within 50 milliseconds, select the strongest signal and relay only that signal to the control center, thus assuring consistent coverage throughout the area.

In addition to providing greater efficiency in communications, the TAC system enables personnel to leave their vehicles and still be in touch with headquarters. *Motorola Communications & Electronics Inc.*

U/G cable closure gives moisture sealing (108)

A new Hyseal underground cable closure offers positive moisture protection for sub-surface access points, with easy reentry in buried cable systems. A tapered end will accommodate almost any combination of cable diameters entering the closure. A fast gelling urethane compound is used to seal the cable entry and protect the conductor bundles from moisture. A sturdy PVC dome which can be easily removed and resealed protects the splice.

The Hyseal closures are available in four sizes to accommodate any combination of cable bundles from 1" to 6" diameters. *Hysol Division, The Dexter Corp.*



Plastic tapes can mark underground cables (109)

Durable, brightly colored, plastic marking tapes, designed to be buried with underground conduits, and cables, for their detection, protection, and identification are designated Terra Tape and Terra Tape D. Terra Tape is a polyethylene strip, available in widths of 3 to 36 inches, and lengths up to 5,000 ft.

Terra Tape D has a one mil steel foil core, overlaid by an adhesive, pin-hole free, plastic jacket. Produced in two-inch widths, and 1,000 and 2,000-foot lengths, it is readily detected by any standard electronic detection device.

Both types of tape come in several bright colors for color-code identifications purposes and bear standard or special messages in easy-to-read black letters imprinted every 24 inches. Terra Tape and Terra Tape D can be buried from six inches to two feet deep. *U.S. Steel Corp.*

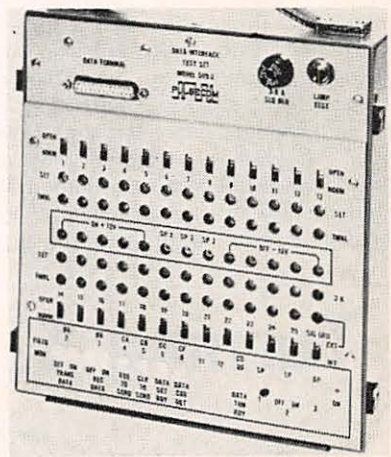
Hot-spot roundel gives brighter signal (110)

Brighter highway signal crossing light indication from most every distance is among features of the new hot-spot roundel 5357. It is said to be designed to assure consistent overall brightness from a distance of 25 ft to 1500 ft from the flashing light. Its peak candlepower is 4,750 at 1,500 ft.

Made of high-impact plastic, the 5357 hot-spot roundel is 8-3/8" diameter. It has a 10 deg vertical spread; and a horizontal spread of 20 deg in one direction, which is reversible. *Western-Cullen Division, Federal Sign & Signal Corp.*

Wire and cable devices are available (111)

Scotch electrical products include vinyl plastic electrical tapes, pads, coatings and compounds. Also included in a new brochure is information about electrical splicing and terminating kits; electrical connectors and sealing packs; communications connectors and tools; wire and cable holding devices and communications flat cable and accessories. *Electro-Products Div. 3M Co.*



Test set permits trouble sectionalizing (112)

A new test instrument allows data terminal users to sectionalize troubles between the terminal and its associated modem (data set). This test set (model 505) provides both access and control at all the leads of the RS-232 interface connector which is the demarcation line between the data set and the terminal equipment.

Its simplicity allows users of limited technical skill to correctly isolate faults to either the data set or the terminal. Model 505 provides convenient access to both sides of the interface for the insertion of oscilloscopes, error rate analyzers and related equipment. It can also simplify the simulation and testing of the various control functions. For example, analysis of the data set request-to-send, clear-to-send function is reduced to throwing a switch and observing a lamp indicator without any need for using the terminal equipment. *Pulse Communications.*

NEWS BRIEFS

(Continued from page 33)

ly, operation is by signal indication under centralized traffic control in which control signals are of the searchlight type and intermediate signals are of the colorlight type. Also, dispatcher to train communications via radio is maintained. The major vehicular crossings are protected by either flashing lights or flashing lights and gates. To assure compliance of signal indication, signal tests are performed regularly by operating personnel.

Greyhound has interest in SP microwave

Greyhound Corp., which has supported the Federal Communications Commission's staff analysis in the domestic common carrier point-to-point microwave discussion, has said: "in actual fact, the Commission has clearly been moving in the direction of permitting greater competition in the common carrier communications field." Greyhound expressed particular interest in the system proposed by Southern Pacific. SP has filed, with the Commission, a proposal to provide specialized communications services via its microwave system from Seattle, Wash. to San Diego, Calif., and from Los Angeles, Calif. to St. Louis, Mo.

Railroad Engineering Conference set for April

Dr. William J. Ronan, head of New York State's Metropolitan Transportation Authority, is scheduled as one of the speakers at the 1971 Joint Railroad Conference of the Institute of Electrical and Electronics Engineers and the American Society of Mechanical Engineers. This two-day conference, sponsored annually by the two engineering groups, is to be held at the Statler Hilton in New York City on April 20 and 21, 1971.

The four technical sessions are to feature a series of papers on contemporary railway technology by American and overseas authors. Among the topics scheduled for discussion are locomotive simulators, the impact of railway electrification on signaling and communications, the design of locomotive trucks, and new approaches to train control. IEEE's Land Transportation Committee and ASME's Rail Transportation Division direct the preparation of technical presentations. Inspections of several

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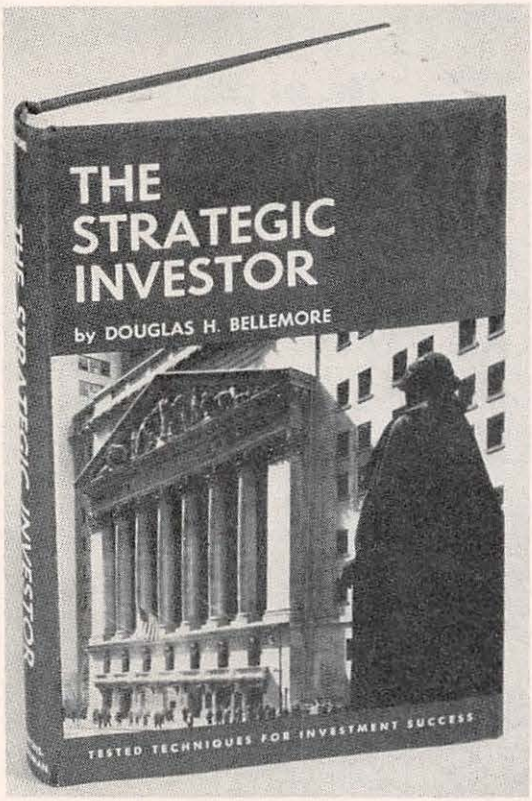

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new transportation facilities in the New York City area are planned during the 1971 Conference.

Six railroads bought GRS hotbox detectors

Six railroads, during 1970, purchased a total of 19 Wheel Thermo-Scanner units from General Railway Signal Co. The roads and the number of units purchased are as follows: Burlington Northern—4; Chicago & North Western—2; Denver & Rio Grande Western—2; Erie Lackawanna—2; Frisco—6; and Gulf, Mobile & Ohio—3.

Texas & Pacific will install microwave

Work will begin this year on construction of a microwave system on the Texas & Pacific between Alexandria and New Orleans, La., 194 miles. The system will provide additional communications circuits for the MP-T&P transportation control system. Also, T&P will upgrade line wire communications circuits between Ft. Worth and Ranger, Tex.

Toronto Transit awards new signal contract

A 3-part signal contract, totaling $5-million, has been awarded by the Toronto Transit Commission to the Uniswitch Division of WABCO. The contract covers manufacture and installation of the signal system for the 5.5-mile extension to TTC's Yonge Street subway extension, improvements to the existing signal system on the Yonge subway line and the conversion of the present manual emergency crossover at Bloor Station to electrical remote control operation.

Railroads can report via EDP to ICC

Interstate Commerce Commission's Bureau of Accounts, in providing an alternate plan for reporting monthly and annual wage statistics by all Class 1 railroads, said that roads with computer capability may elect to furnish the data on prescribed computer printouts in lieu of present report forms A and B. At the same time, they will furnish card decks or magnetic tape providing the information which can be processed directly by the ICC computer. In August, 1969, ICC permitted Class 1 line-haul railroads and Class 1 motor carriers to file annual freight commodity data by similar computer process reports.

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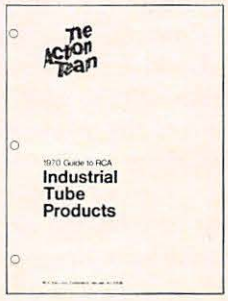

Need more reasons? Call your local RCA Industrial Tube Distributor. For starters, ask him for the new 1970 Guide to RCA Industrial Tube Products, or write: RCA Electronic Components, Commercial Engineering, Dept. 135K, Harrison, N. J. 07029.

RCA

Editor's Corner

Railroads are important to our country

Obviously to readers of this magazine, the above title is not new or startling. But what is worth a comment or two is that we seem to be in a minority. I suspect that we are too close to railroads to really understand why the public and its representatives in Congress do not really believe that *railroads are necessary for sustaining the general welfare of the United States.*

Apparently railroads' spirit of independence to maintain autonomy and be as free as possible from government control or involvement has convinced the public and Congress that they not only *do not* spend taxpayers' money on railroads, but they do just the opposite—help railroads' competition.

There has been some cheering news in recent weeks that Congress has finally awakened to the fact that federal help to the railroads—including rail transit—is necessary. For example, Congress set up the National Railroad Passenger Corp. with $40 million as a grant to get it started. This amount will be augmented by funds from participating railroads. Also, Congress passed a $125 million loan guarantee bill for railroads in reorganization. And the Urban Mass Transportation Act of 1970—with an intent to spend $10 billion in 12 years—will start off with approximately $600 million the first year.

COMPETITION GETS BILLIONS

On the other side of the ledger, look what Congress has done for railroads' competitors. Billions of dollars are spent each year for federal highways. To keep the supersonic transport "alive", Congress has appropriated another $210 million. Lockheed Aircraft will probably receive anywhere from $200 to $900 million from Congress to help bail it out of the overrun cost of the C-5A cargo plane it is building for the U.S. Air Force.

It is interesting to recall that in 1960, the Air Force in cooperation with several railroads operated four missile trains on a test basis. Each train was ultimately to be self-contained with power, missile cars, crew quarters, etc., to permit it to operate continuously over the U.S., stopping only for fuel and supplies.

These tests, with a few prototype cars, were to be the anti-ballistic missile defense of the U.S. However, in the spring of 1961, due to a cut in funds, the Air Force decided to go for fixed missile site installations rather than moving trains with missile launching cars. If that missile train concept had been carried out, think of the federal funds that might have been available to railroads for upgrading trackage and bridges to carry those missile trains. Instead of $900 million for Lockheed, there might have been $500 million or $1 billion for U.S. railroads.

LET'S IMPLEMENT ASTRO

Back to the present. There are ways for U.S. railroads to become involved with the federal government that might well bring home their importance to the general public. Railpax is a start and a proposed federally-charted National Freight Car Corp. is another area of federal government-railroad cooperation that can be helpful. But what can also be helpful is the implementation of the ASTRO (America's Sound Transportation Review Organization) report.

Of specific concern to our readers would be the plant and equipment section of the ASTRO report concerning grade crossing projects. It says that states should be required to devote 10% of the federal highway funds to grade-crossing projects, and establish uniform safety standards for all grade crossings. Also, it seems logical that signal systems can be considered to improve right-of-way modernization, another key item for possible loan guarantees or money from a Federal Transportation Fund.

What is needed now is the type of cooperative action at the federal level that is now well established by many railroads at the state level. Cooperative programs for improving protection at railroad-highway grade crossings have been in existence since the 1930's between railroads and state governments. Often these programs—paying up to 90% of the installation costs —are also shared by city and county governments.

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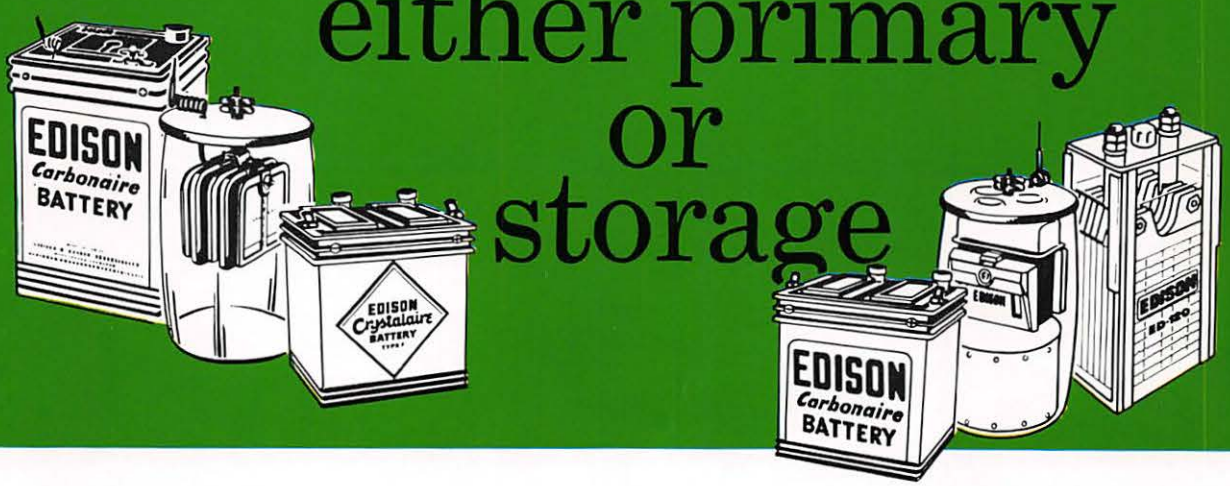

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